BLM LIBRARY
88047026

United States Department of the Interior
Bureau of Land Management

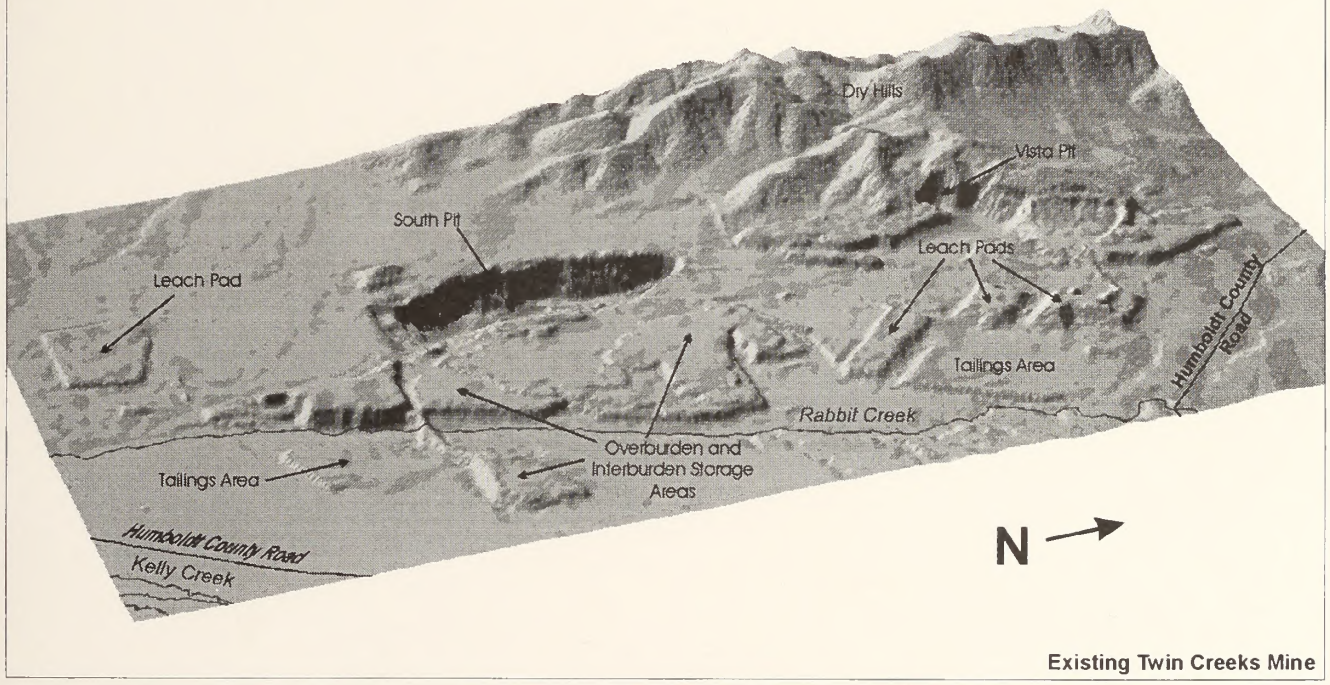
Winnemucca District Office
Winnemucca, Nevada

December 1996

Final
Environmental Impact Statement

Twin Creeks Mine

Volume II



Existing Twin Creeks Mine

BLM LIBRARY
RS 150A BLDG. 50
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, CO 80225

TD88047026

BLM LIBRARY
RS 150A BLDG. 50
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, CO 80225

TD
195
.E3
T95
1996
V.
C.

VOLUME II

TABLE OF CONTENTS

Page

APPENDIX A - Summary of Water Quality Data A-1

APPENDIX B - Wildlife Species Lists B-1

APPENDIX C - Ecological Risk Assessment C-1

APPENDIX D - Human Health Risk Assessment D-1

APPENDIX E - National Register of Historic Places Status of Cultural Resources Within the Project Area E-1

APPENDIX F - Public Comments and Responses to the Draft EIS F-1

LIST OF TABLES

Table No.		Page
A-1	Surface Water Quality Monitoring Data	A-1
A-2	Ground Water Quality Monitoring Data	A-13
A-3	Treated Mine Water Discharge to Rabbit Creek	A-27
A-4	Water Quality Data for Water Discharged to the Reinfiltration Basins	A-28
A-5	Summary of Meteoric Water Mobility Procedure Test Data for Mine Rock	A-29
B-1	Wildlife Species List, Lower Sagebrush/Grassland Steppe, Northeastern Nevada	B-1
B-2	Species Occurrence, Humboldt River Study Database	B-4
C-1	Predicted Pit Lake Characteristics	C-2
C-2	Predicted Pit Lake Habitat Conditions	C-2
C-3	Receptor Species	C-3
C-4	Exposure Pathways	C-5
C-5	Acute and Chronic Exposure Routes	C-6
C-6	Values Used to Calculate Chemical Dose	C-7
C-7	Bioconcentration Factors	C-7
C-8	Hazard Quotients for Affected Species, Screening-Level Risk Assessment	C-9
C-9	Sources of Uncertainty in the Screening-Level Risk Assessment	C-9
C-10	Hazard Quotients for Affected Species, Baseline Risk Assessment	C-11
C1-1	Projected Reductions in Little Brown Myotis Longevity	C1-2
C2-1	Exposure Assumptions for the Bald Eagle in the Twin Creeks Mine No Action and Proposed Action Pit Lakes: Baseline Risk Assessment	C2-2
C2-2	Avian Toxicity Data for the Twin Creeks Mine No Action and Proposed Action Pit Lakes: Baseline Risk Assessment	C2-2
C2-3	Water Concentrations, Estimated Environmental Doses, and Hazard Quotients: No Action Alternative	C2-3
C2-4	Water Concentrations, Estimated Environmental Doses, and Hazard Quotients: Proposed Action	C2-5
D-1	Potential Exposure Pathways	D-2
D-2	Summary of Chemical-Specific Parameters Used in the Human Health Risk Assessment	D-2
D-3	Sources of Uncertainty in the Human Health Risk Assessment of Thallium	D-4
E-1	National Register of Historic Places Status of Cultural Resources Within the Project Area	E-1
F1-1	Oxygen Loading to Dewatered and Rewetted Sulfide Bedrock Due to Diffusive Transport	F1-3

LIST OF FIGURES

Figure No.		Page
F-1	No Action Alternative Without Sections 13, 25, and 36	F-111
F-2	Proposed Action Without Sections 13, 25, and 36	F-115
F1-1	Conceptual Schematic of Sulfide Bedrock Oxidation Due to Advective Oxidation	F1-4
F1-2	Conceptual Schematic of Sulfide Bedrock Oxidation Due to Diffusive O_2 Loading	F1-5
F1-3	Geologic Section Along 40000N	F1-6

APPENDIX A

Summary of Water Quality Data

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
Streams															
SW-02	Kelly Creek at	11/16/95	7.71	8.8	144	79.8	72	16.40	2.82	21.4	4.45	9.0	10.9	n/a	<0.078
	Kelly Creek	8/10/95	7.11	17.9	135	79.8	65	14.2	3.89	19.4	4.12	5.5	10.1	<0.02	0.200
	Ranch	5/15/95	7.70	10.8	102	46.8	41	10.8	2.07	12.2	2.46	5.0	8.1	0.26	0.115
		3/20/95	7.40	7.3	93	50	44	12.1	2.1	13.4	2.64	5.6	9.4	<0.02	<0.082
		6/15/94	7.83	20.8	121	66	54	13.0	2.8	16.0	3.3	6.1	8.6	<0.1	<0.1
		3/8/94	7.50	13.9	137	63	70	16.0	3.0	21.0	4.3	11.0	17.0	<0.1	<0.1
SW-03	Kelly Creek at	8/10/95	7.07	15.9	164	106	84	18.7	2.75	25.5	4.83	5.7	9.9	<0.02	<0.1
	Corral S. of	5/16/95	7.77	15.4	137	68.6	64	14.4	3.19	19.5	3.81	7.6	12.4	0.13	0.090
	Kelly Creek Rn.	3/20/95	7.60	8.6	138	84	82	17.8	3.55	24.8	4.88	9.0	16.3	<0.02	0.089
		6/15/94	7.67	17.7	162	90	74	18.0	3.4	23.0	4.1	8.0	12.0	<0.1	<0.1
		3/8/94	7.15	14.0	196	107	98	22.0	3.0	30.0	5.7	11.0	17.0	0.1	<0.1
SW-04	Kelly Creek	5/15/95	7.93	12.6	233	68.7	70	15.3	3.25	20.1	4.92	8.3	20.4	0.16	<0.082
	at Midas Rd.	3/21/95	7.70	10.1	168	100	111	19.5	3.73	28.9	9.34	11.1	42.2	<0.02	<0.082
		3/9/94	8.11	14.6	314	117	214	28.0	5.1	51.0	21.0	21.0	116	<0.1	<0.1
SW-05	Jake Creek	11/15/95	7.14	9.1	107	56.9	48	11.5	1.13	14.7	2.7	3.7	7.3	n/a	0.104
	Hammond Rn.	8/10/95	7.00	21.0	77	45.5	34	8.88	1.63	10.3	1.9	3.6	5.6	<0.02	0.100
		5/31/95	7.62	17.7	82	32.6	22	6.93	1.49	6.62	1.28	3.0	5.1	0.07	<0.082
		3/20/95	7.00	7.9	55	31	25	8.39	1.55	7.63	1.47	3.7	7.1	0.05	<0.082
		9/21/94	7.84	20.6	126	67	55	13.0	2.4	17.0	3.0	7.0	8.0	<0.1	<0.1
		6/16/94	7.53	23.5	83	42	31	9.4	1.9	9.8	1.7	3.7	5.9	<0.1	<0.1
		3/11/94	7.31	6.8	99	38	42	11.0	2.0	13.0	2.4	7.0	14.0	0.2	0.1
SW-06	Jake Creek S.	11/15/95	8.19	12.1	72	87.6	72	15.9	3.04	21.5	4.45	5.1	9.6	n/a	<0.078
	of Desmond Rn.	8/10/95	8.51	20.3	128	90.7	74	14	3.5	22.2	4.62	4.2	7.3	<0.02	0.100
		5/15/95	7.68	10.7	99	44.6	39	9.55	2.61	11.7	2.37	4.8	7.6	0.11	<0.082
		3/20/95	7.20	8.5	70	39	32	9.41	1.9	9.74	1.92	4.3	8.6	0.05	<0.082
		6/16/94	9.30	23.4	140	84	61	17.0	4.1	19.0	3.4	6.5	8.7	<0.1	<0.1
		3/11/94	7.54	7.7	129	59	57	14.0	3.0	17.0	3.6	7.0	14.0	0.1	<0.1
SW-07	Evans Creek	11/15/95	7.51	10.5	38	22.9	15	5.78	1.58	4.51	0.919	2.1	4.2	n/a	<0.078
	above Jake Creek	8/9/95	7.49	19.3	60	24.2	17	4.96	1.65	4.97	1	1.8	2.6	0.10	0.083
		5/15/95	7.54	11.3	82	32.4	24	7.75	1.66	7.14	1.52	3.1	4.4	0.20	<0.082
		3/20/95	6.80	9.7	63	37	25	8.98	1.38	7.27	1.56	3.9	6.6	0.18	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Streams																
SW-02	Kelly Creek at	11/16/95	<0.003	<0.04	0.026	<0.0024	<0.005	<0.003	0.4	0.0450	<0.0002	0.003	<0.001	<0.001	<0.04	<0.002
	Kelly Creek	8/10/95	<0.0022	<0.042	0.026	<0.0019	<0.002	<0.0017	0.5	0.0425	<0.0002	0.0088	<0.001	<0.001	<0.001	<0.0019
	Ranch	5/15/95	<0.002	<0.04	0.015	<0.002	<0.003	<0.003	0.18	0.034	<0.0002	0.0106	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.019	<0.002	<0.003	<0.003	0.4	<0.017	<0.0002	0.0160	<0.04	<0.018	<0.001	<0.002
		6/15/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-03	Kelly Creek at	8/10/95	<0.0022	<0.042	0.025	<0.0019	<0.002	<0.0017	0.50	0.0037	<0.0002	0.0019	<0.001	<0.001	<0.001	<0.0019
	Corral S. of	5/16/95	<0.002	<0.04	0.025	<0.002	<0.003	<0.003	0.34	<0.017	<0.0002	0.0153	<0.04	<0.018	<0.001	<0.002
	Kelly Creek Rn.	3/20/95	<0.002	<0.04	0.032	<0.002	<0.003	<0.003	0.50	0.025	<0.0002	0.005	<0.04	<0.018	<0.001	<0.002
		6/15/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-04	Kelly Creek	5/15/95	<0.002	<0.04	0.021	<0.002	0.004	<0.003	0.35	0.021	<0.0002	0.0065	<0.04	0.023	<0.001	<0.002
	at Midas Rd.	3/21/95	<0.002	<0.04	0.035	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	0.007	<0.04	<0.018	<0.001	<0.002
		3/9/94	<0.0005	0.037	<0.1	<0.0002	<0.05	<0.1	0.7	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-05	Jake Creek	11/15/95	<0.003	<0.04	0.020	<0.0024	<0.005	<0.003	0.40	0.262	<0.0002	0.1180	<0.001	<0.001	<0.04	<0.002
	Hammond Rn.	8/10/95	<0.0022	<0.042	0.018	<0.0019	<0.002	0.0017	0.40	0.206	<0.0002	0.0552	<0.001	<0.001	<0.001	<0.0019
		5/31/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.21	0.069	<0.0002	0.0136	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.014	<0.002	<0.003	<0.003	0.40	0.046	<0.0002	0.0170	<0.04	<0.018	<0.001	<0.002
		9/21/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	0.2	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/16/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.2	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.2	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-06	Jake Creek S.	11/15/95	<0.003	<0.04	0.037	<0.0024	<0.005	<0.003	0.60	0.027	<0.0002	0.0040	<0.001	<0.001	<0.04	<0.002
	of Desmond Rn.	8/10/95	<0.0022	<0.042	0.036	<0.0019	<0.002	<0.0017	0.50	0.0336	<0.0002	0.0125	<0.001	<0.001	<0.001	<0.0019
		5/15/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.40	0.034	<0.0002	0.0142	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.50	0.018	<0.0002	0.0090	<0.04	<0.018	<0.001	<0.002
		6/16/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-07	Evans Creek	11/15/95	<0.003	<0.04	0.010	<0.0024	<0.005	<0.003	0.20	0.115	<0.0002	0.0040	<0.001	<0.001	<0.04	<0.002
	above Jake Creek	8/9/95	<0.002	<0.04	0.012	<0.002	<0.003	<0.003	0.10	0.043	<0.0002	0.003	0.002	<0.001	<0.041	0.002
		5/15/95	<0.002	<0.04	0.025	<0.002	<0.003	<0.003	0.12	0.038	<0.0002	0.0027	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.028	<0.002	<0.003	<0.003	0.20	<0.017	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SW-07	Evans Creek	9/20/94	7.20	15.7	63	29	21	5.9	1.4	6.2	1.3	2.0	3.0	0.1	<0.1
(cont.)	above Jake Creek	6/17/94	7.41	21.6	74	21	13	4.9	1.0	3.8	0.8	1.5	2.5	<0.1	<0.1
		3/11/94	6.55	6.4	86	22	21	7.7	1.6	6.1	1.4	6.0	9.0	1.2	0.4
SW-08	Evans Creek at Hot Springs Rn.	3/22/95	7.80	7.9	125	61	52	15.1	4.91	15.6	3.17	7.0	13.5	<0.02	0.098
SW-09	Rabbit Creek	11/16/95	7.76	15.3	296	129	208	29.5	4.24	48.0	21.4	20.3	91.8	n/a	<0.078
	at GFW Wells	8/10/95	8.20	23.9	320	88.2	220	28.2	4.18	54.0	20.7	15.7	165	<0.02	<0.1
		5/16/95	8.40	25.1	300	125	200	27.6	4.55	47.2	19.9	19.3	96.4	<0.02	<0.082
		3/21/95	8.30	15.8	267	125	197	27.7	4.61	45.7	20.3	20.0	94.0	0.04	<0.082
		11/28/94	8.30	13.6	281	122	199	27.6	4.8	46.6	20.2	20.5	97.0	0.18	<0.3
		9/21/94	8.18	23.7	338	86	198	26.0	4.1	48.0	19.0	17.0	130	<0.1	<0.1
		6/15/94	8.34	24.2	301	108	184	27.0	4.7	44.0	18.0	18.0	110	<0.1	<0.1
		3/11/94	7.89	13.9	322	115	197	30.0	4.7	46.0	20.0	19.0	123	0.3	0.3
SW-10	Rabbit Creek at	11/15/95	8.17	15.6	297	117	195	28.9	4.65	45.1	20.1	21.2	102	n/a	<0.078
	power line road	8/10/95	8.73	23.3	349	95.5	228	28.9	3.8	56.0	21.4	16.5	169	0.02	0.200
		5/16/95	8.88	25.8	277	114	185	28.2	4.75	41.7	19.7	20.3	88.9	<0.02	<0.082
		3/21/95	8.60	15.8	258	122	192	27.8	4.74	43.5	20.2	19.0	99.0	<0.02	<0.082
		11/28/94	8.40	12.8	300	127	206	28.4	5.2	48.2	20.9	19.9	92.5	0.17	<0.3
		9/20/94	8.85	26.4	307	65	178	26.0	4.4	40.0	19.0	17.0	140	<0.1	<0.1
		6/15/94	8.66	23.4	289	33	166	28.0	5.0	37.0	18.0	18.0	110	<0.1	<0.1
		3/8/94	7.54	15.9	328	117	202	29.0	3.9	48.0	20.0	23.0	107	0.1	<0.1
SW-11	Rabbit Creek	11/16/95	8.14	11.5	300	122	199	28.8	4.36	46.2	20.3	20.9	97.8	n/a	<0.078
	at flume	8/10/95	8.84	24.3	334	89.5	214	28	3.85	51.7	20.6	16.9	164	<0.02	0.100
		5/16/95	8.82	24.8	267	112	182	27.7	4.69	41.1	19.3	20.3	88.5	<0.02	<0.082
		3/21/95	8.40	14.9	261	122	189	27.8	4.6	42.9	20	20.0	98.0	<0.02	<0.082
		9/20/94	8.95	24.9	320	60	169	26.0	4.5	38.0	18.0	17.0	140	<0.1	<0.1
		6/15/94	8.69	22.9	283	86	161	28.0	5.1	35.0	18.0	18.0	110	<0.1	<0.1
		3/8/94	8.08	10.2	312	126	205	29.0	4.8	49.0	20.0	20.0	109	0.1	0.1
SW-12	Kelly Creek	5/16/95	8.02	9.6	179	73.5	78	16.1	3.24	22.0	5.6	9.1	21.7	0.11	<0.082
	at Dudley Ranch	3/21/95	7.60	9.2	164	94	110	19.5	3.41	28.8	9.32	11.4	42.1	<0.02	<0.082
		3/9/94	8.06	12.9	308	126	214	27.0	5.2	51.0	21.0	21.0	112	0.4	<0.1

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SW-07	Evans Creek	9/20/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.2	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
(cont.)	above Jake Creek	6/17/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.1	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.3	0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-08	Evans Creek at Hot Springs Rn.	3/22/95	<0.002	<0.04	0.026	<0.002	<0.003	<0.003	0.40	0.073	<0.0002	0.0050	<0.04	<0.018	<0.001	<0.002
SW-09	Rabbit Creek	11/16/95	<0.003	<0.04	0.057	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.0060	<0.001	0.028	<0.04	<0.002
	at GFW Wells	8/10/95	<0.0022	<0.042	0.050	<0.0019	<0.002	0.0017	0.70	0.0168	<0.0002	0.0027	<0.001	0.013	<0.001	0.0031
		5/16/95	<0.002	<0.04	0.051	<0.002	<0.003	0.0033	0.71	<0.017	<0.0002	0.0075	<0.04	0.047	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.050	<0.002	0.004	<0.003	0.70	<0.017	<0.0002	0.006	<0.04	0.046	<0.001	<0.002
		11/28/94	<0.004	<0.04	0.044	<0.004	<0.004	<0.003	0.69	0.029	<0.0002	0.006	<0.04	0.05	0.001	<0.004
		9/21/94	<0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	0.7	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0006	0.013	<0.1	0.0003	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	0.0006	0.015	<0.1	<0.0002	<0.05	<0.1	0.6	0.2	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-10	Rabbit Creek at	11/15/95	<0.003	<0.04	0.056	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.0100	<0.001	0.029	<0.04	<0.002
	power line road	8/10/95	<0.0022	<0.042	0.043	0.0025	<0.002	<0.0017	0.70	0.0031	<0.0002	<0.0009	<0.001	0.014	<0.001	<0.0019
		5/16/95	<0.002	<0.04	0.048	<0.002	<0.003	<0.003	0.72	<0.017	<0.0002	0.0052	<0.04	0.033	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.047	<0.002	<0.003	<0.003	0.70	<0.017	<0.0002	0.0040	<0.04	0.025	<0.001	<0.002
		11/28/94	<0.004	<0.04	0.05	<0.004	<0.004	<0.003	0.69	0.023	<0.0002	0.006	<0.04	0.07	0.001	<0.004
		9/20/94	<0.0005	0.014	<0.1	<0.0002	<0.05	<0.1	0.7	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0006	0.025	<0.1	0.0003	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0006	0.023	<0.1	<0.0002	<0.05	<0.1	0.5	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-11	Rabbit Creek	11/16/95	<0.003	<0.04	0.059	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.0050	<0.001	0.028	<0.04	<0.002
	at flume	8/10/95	<0.0022	0.05	0.031	<0.0019	<0.002	<0.0017	0.70	0.0048	<0.0002	0.0022	<0.001	0.017	<0.001	<0.0019
		5/16/95	<0.002	<0.04	0.049	<0.002	<0.003	<0.003	0.71	<0.017	<0.0002	0.0139	<0.04	0.034	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.047	<0.002	<0.003	<0.003	0.70	<0.017	<0.0002	<0.001	<0.04	0.022	<0.001	<0.002
		9/20/94	<0.0005	0.018	<0.1	<0.0002	<0.05	<0.1	0.7	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0005	0.028	<0.1	0.0003	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0007	0.023	<0.1	<0.0002	<0.05	<0.1	0.5	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-12	Kelly Creek	5/16/95	<0.002	<0.04	0.024	<0.002	<0.003	<0.003	0.42	<0.017	<0.0002	0.0033	<0.04	<0.018	<0.001	<0.002
	at Dudley Ranch	3/21/95	<0.002	<0.04	0.034	<0.002	<0.003	<0.003	0.50	<0.017	<0.0002	0.006	<0.04	<0.018	<0.001	<0.002
		3/9/94	<0.0005	0.025	<0.1	<0.0002	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SW-13	Chimney Creek	11/16/95	7.86	12.1	266	124	93	46.1	8.34	28.5	5.42	18.0	27.8	n/a	0.383
	Reservoir Dam	8/9/95	8.09	20.6	211	99.3	73	33.1	7.47	22.1	4.32	14.3	20.0	0.07	0.191
		5/17/95	7.86	11.5	159	80.9	57	28.1	5.51	17.1	3.37	12.3	18.3	0.02	0.137
		3/22/95	8.10	7.8	216	110	72	45.4	6.86	21.8	4.27	19.0	26.0	0.04	0.198
		11/28/94	8.20	4.7	317	165	117	60.8	10.8	36.0	6.61	26.1	34.2	0.29	0.4
		9/21/94	8.21	16.6	298	14	101	49.0	11.0	31.0	5.7	21.0	29.0	0.3	<0.1
		6/15/94	8.10	16.5	248	122	81	44.0	9.4	25.0	4.4	19.0	25.0	0.2	<0.1
		3/8/94	8.15	9.3	281	113	85	44.0	9.9	26.0	4.9	20.0	44.0	0.4	0.6
SW-15	Kelly Creek E.	5/16/95	7.87	16.9	128	63.4	58	13.9	3.33	17.6	3.45	7.8	12.0	0.13	<0.082
	of Alkali Spring	3/21/95	7.70	11.1	131	75	66	15.6	3.1	20.1	3.95	7.4	13.0	<0.02	<0.082
SW-16	Jake Creek	11/17/95	8.27	8.7	110	88.6	75	17	3.14	22.4	4.61	5.1	9.6	n/a	<0.078
	at Midas Rd.	8/9/95	8.87	25.9	152	94.1	70	13.7	3.67	21.0	4.23	4.4	6.2	<0.02	0.095
		5/15/95	7.71	10.3	69	45.2	39	9.46	2.45	11.7	2.35	4.6	7.6	0.13	0.108
		3/20/95	7.20	8.9	58	38	33	9.77	1.93	10.1	1.99	4.5	8.7	0.03	<0.082
		6/16/94	8.76	21.8	142	89	70	16.0	3.4	21.0	4.3	6.4	8.6	<0.1	<0.1
		3/11/94	7.46	4.7	140	69	63	14.0	2.7	19.0	3.9	9.0	15.0	0.5	<0.1
SW-17	Kelly Creek at	5/16/95	8.47	19.6	140	78.3	76	20.8	4.59	22.3	5.02	9.8	23.0	<0.02	<0.082
	Diesel Tank Road	3/22/95	8.10	8.9	182	93	110	21.1	3.96	28.6	9.36	11.7	41.7	<0.02	<0.082
SW-18	Kelly Creek	3/22/95	8.60	6.3	336	188	112	84	6.37	31.4	8.16	28.0	48.8	<0.02	<0.082
	Cut-off Ditch			-13.5											
SW-19	Hammond Ditch	5/16/95	8.66	21.9	225	103	81	33.1	5.93	24.3	5.06	14.8	24.4	<0.02	0.151
		3/30/95	8.50	8.1	264	162	138	62.0	6.03	38.2	10.5	21.9	51.4	<0.02	<0.082
		9/20/94	9.29	26.7	356	159	53	89.0	6.9	16.0	3.3	23.0	34.0	<0.1	<0.1
SW-21	Spring Creek	11/16/95	7.85	12.1	262	127	129	31.4	6.94	44.2	4.6	21.9	35.7	n/a	0.114
		8/9/95	7.44	21.0	218	133	119	29.9	3.19	40.6	4.35	18.8	19.4	<0.02	0.086
		5/17/95	8.05	13.6	135	83.4	79	23.1	4.28	25.4	3.81	16.2	21.1	<0.02	0.117
		3/22/95	8.20	7.2	270	128	139	35.1	4.49	48.3	4.55	23.0	44.2	<0.02	<0.082
SW-22	N Fork Little	6/2/95	7.98	18.8	201	121	82	32.9	5.82	23.3	5.72	9.6	9.8	<0.02	0.218
	Humboldt River	3/22/95	7.90	7.4	166	78	54	30.3	6.35	15.6	3.75	11.3	20.3	0.03	0.124
SW-23	Kelly Creek	5/17/95	8.91	19.1	390	176	64	113	9.22	18.4	4.39	46.0	49.2	0.02	<0.082
	Above Humboldt	3/20/95	8.50	8.4	456	242	80	139	8.55	23.4	5.36	47.0	61.2	<0.02	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SW-13	Chimney Creek	11/16/95	<0.003	<0.04	0.032	<0.0024	<0.005	<0.003	1.10	0.205	<0.0002	0.0160	<0.001	<0.001	<0.04	0.002
	Reservoir Dam	8/9/95	<0.002	<0.04	0.028	<0.002	<0.003	<0.003	0.90	0.371	<0.0002	0.045	<0.001	<0.001	<0.041	<0.002
		5/17/95	<0.002	<0.04	0.026	<0.002	<0.003	0.0075	0.82	0.116	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.027	<0.002	<0.003	<0.003	1.70	0.059	<0.0002	0.070	<0.04	<0.018	<0.001	<0.002
		11/28/94	<0.004	<0.04	0.038	<0.004	<0.004	<0.003	2.54	0.017	<0.0002	0.043	<0.04	<0.02	<0.001	<0.004
		9/21/94	<0.0005	0.013	<0.1	<0.0002	<0.05	<0.1	2.2	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0007	0.011	<0.1	0.0005	<0.05	<0.1	1.7	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0007	0.010	<0.1	<0.0002	<0.05	<0.1	1.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-15	Kelly Creek E.	5/16/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.39	<0.017	<0.0002	0.0082	<0.04	<0.018	<0.001	<0.002
	of Alkali Spring	3/21/95	<0.002	<0.04	0.023	<0.002	<0.003	<0.003	0.50	<0.017	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002
SW-16	Jake Creek	11/17/95	0.067	<0.04	0.034	<0.0024	<0.005	<0.003	0.50	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	0.013
	at Midas Rd.	8/9/95	<0.002	<0.04	0.028	<0.002	<0.003	<0.003	0.50	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
		5/15/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.38	0.042	<0.0002	0.0098	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.40	0.023	<0.0002	0.007	<0.04	<0.018	<0.001	<0.002
		6/16/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-17	Kelly Creek at	5/16/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.0034	<0.04	<0.018	<0.001	<0.002
	Diesel Tank Road	3/22/95	<0.002	<0.04	0.032	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	0.003	<0.04	<0.018	<0.001	<0.002
SW-18	Kelly Creek	3/22/95	<0.002	<0.04	0.016	<0.002	<0.003	<0.003	3.60	<0.017	<0.0002	0.002	<0.04	<0.018	<0.001	<0.002
	Cut-off Ditch															
SW-19	Hammond Ditch	5/16/95	<0.002	<0.04	0.020	<0.002	<0.003	0.0055	0.63	0.03	<0.0002	0.0018	<0.04	<0.018	<0.001	<0.002
		3/30/95	<0.005	<0.04	0.0228	<0.005	<0.003	<0.010	2.51	<0.050	<0.0002	0.0018	<0.04	<0.018	0.002	<0.0050
		9/20/94	<0.0005	0.006	<0.1	<0.0002	<0.05	<0.1	7.0	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
SW-21	Spring Creek	11/16/95	<0.003	<0.04	0.040	<0.0024	<0.005	<0.003	2.70	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
		8/9/95	<0.002	<0.04	0.029	<0.002	<0.003	<0.003	1.90	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
		5/17/95	<0.002	<0.04	0.027	<0.002	<0.003	0.0097	0.54	0.075	<0.0002	0.0015	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.031	<0.002	<0.003	<0.003	2.80	<0.017	<0.0002	0.001	<0.04	<0.018	<0.001	<0.002
SW-22	N Fork Little	6/2/95	<0.002	<0.04	0.036	<0.002	<0.003	<0.003	1.2	0.035	<0.0002	0.018	<0.04	<0.018	<0.001	<0.002
	Humboldt River	3/22/95	<0.002	<0.04	0.034	<0.002	<0.003	<0.003	0.9	0.156	<0.0002	0.005	<0.04	<0.018	<0.001	<0.002
SW-23	Kelly Creek	5/17/95	<0.002	0.06	0.008	<0.002	<0.003	0.0075	2.80	0.047	<0.0002	0.0078	<0.04	0.020	<0.001	<0.002
	Above Humboldt	3/20/95	<0.002	0.05	0.009	<0.002	<0.003	0.004	5.00	0.039	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SW-24	Above Kelly Creek Ranch	11/16/95	7.73	9.7	154	80.9	73	17.4	1.63	21.6	4.52	9.7	11.4	n/a	0.097
Springs															
SPG-02	Dog Spring	11/14/95	7.32	14.3	325	178	221	38.5	1.32	50.0	23.5	48.9	53.7	n/a	<0.078
		8/8/95	7.51	16.0	332	179	228	37.6	2.07	51.3	24.3	49.0	54.6	0.77	<0.082
		5/31/95	7.31	16.0	342	180	238	40.9	2.00	53.8	25.3	51.1	50.2	0.87	<0.082
		3/30/95	7.40	13.2	236	175	241	39.7	1.94	55.8	24.8	50.3	53.5	0.86	<0.082
		9/22/94	7.49	16.7	346	167	228	38.0	1.90	52.0	24.0	47.0	54.0	0.8	<0.1
		6/17/94	7.22	18.2	356	175	213	38.0	2.20	49.0	22.0	48.0	54.0	1.0	<0.1
		3/10/94	7.18	14.2	353	180	239	40.0	2.00	53.0	26.0	47.0	60.0	0.8	<0.1
SPG-03	Garden Spring	11/14/95	7.26	14.2	212	124	137	25.4	2.02	35.6	11.6	24.8	23.8	n/a	<0.078
		8/8/95	7.35	16.1	211	123	136	24.2	1.85	35.3	11.6	24.5	27.0	1.57	0.083
		5/31/95	7.34	14.8	228	125	141	25.6	1.89	36.6	12	25.6	25.4	1.67	<0.082
		3/30/95	7.20	13.7	167	122	146	26.0	2.08	38.5	12.1	24.0	25.0	1.65	<0.082
		9/22/94	7.41	15.8	230	119	139	28.0	1.9	36.0	12.0	23.0	23.0	1.6	<0.1
		6/17/94	7.32	19.2	245	123	128	24.0	1.8	33.0	11.0	23.0	23.0	1.6	<0.1
		4/1/94	7.23	12.1	218	116	126	20.0	1.5	34.0	9.9	25.0	23.0	1.6	<0.1
SPG-04	Garret Spring	11/14/95	7.69	14.1	314	189	175	46.0	3.83	52.6	10.5	29.2	28.8	n/a	<0.078
		8/8/95	8.71	27.4	289	159	138	44.8	4.52	39.0	9.94	27.2	31.9	0.54	<0.082
		5/31/95	8.20	20.9	324	193	178	47.3	4.95	53.3	10.9	30.5	30.3	1.17	<0.082
		3/21/95	8.00	13.1	310	191	174	46.1	4.01	52.5	10.5	29.0	29.4	1.34	<0.082
		11/30/94	8.10	13.0	315	189	181	47.8	5.0	54.5	10.9	28.5	28.8	1.57	<0.3
		9/21/94	7.81	16.9	370	184	175	48.0	4.2	52.0	11.0	27.0	28.0	1.8	<0.1
		6/16/94	7.74	20.7	334	185	163	44.0	4.7	50.0	9.4	27.0	28.0	1.9	<0.1
		3/11/94	8.14	10.9	342	183	194	51.0	5.4	58.0	12.0	30.0	37.0	1.5	0.7
SPG-05	Kelly Creek Spring	11/16/95	8.08	11.7	392	237	187	65.7	14.4	52.1	13.9	38.8	36.7	n/a	0.148
		8/8/95	7.91	26.4	407	222	166	52.6	16.4	47.1	11.7	37.5	29.9	0.09	<0.082
		5/31/95	8.10	21.3	335	195	160	50.8	7.33	46.5	10.7	31.3	29.6	0.24	<0.082
		3/22/95	8.40	10.9	306	185	153	52.9	6.59	44.1	10.5	30.0	27.9	0.50	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SW-24	Above Kelly Creek Ranch	11/16/95	<0.003	<0.04	0.021	<0.0024	<0.005	<0.003	0.40	0.272	<0.0002	0.027	<0.001	<0.001	<0.04	<0.002
Springs																
SPG-02	Dog Spring	11/14/95	<0.003	<0.04	0.019	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.0020	<0.04	0.020	<0.002	<0.0030	<0.0030	0.46	<0.017	<0.0002	<0.001	<0.040	<0.018	<0.001	<0.0020
		3/30/95	<0.0050	<0.04	0.020	<0.005	<0.0030	<0.010	0.47	<0.050	<0.0002	0.0018	<0.040	<0.018	<0.001	<0.0050
		9/22/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0007	<0.005	<0.1	0.0005	<0.05	<0.1	0.4	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/10/94	0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-03	Garden Spring	11/14/95	<0.003	<0.04	0.107	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	<0.04	0.092	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	0.003
		5/31/95	<0.002	<0.04	0.106	<0.002	<0.0030	<0.0030	0.42	<0.017	<0.0002	<0.001	<0.040	<0.018	<0.001	<0.0020
		3/30/95	<0.005	<0.04	0.109	<0.005	<0.0030	<0.010	0.47	<0.050	0.0003	<0.001	<0.040	<0.018	<0.001	<0.0050
		9/22/94	<0.0005	0.006	0.1	<0.0002	<0.05	<0.1	0.4	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0009	<0.005	0.1	0.0003	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		4/1/94	0.0006	<0.005	0.1	<0.0002	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-04	Garret Spring	11/14/95	<0.003	<0.04	0.035	<0.0024	<0.005	<0.003	0.90	<0.024	<0.0002	0.0030	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	<0.04	0.026	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.002	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.029	<0.002	<0.003	<0.003	0.96	<0.017	<0.0002	0.0058	<0.04	<0.018	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.033	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.0010	<0.04	<0.018	<0.001	<0.002
		11/30/94	<0.004	<0.04	0.036	<0.004	<0.004	<0.003	0.89	<0.009	<0.0002	0.004	<0.04	<0.02	<0.001	0.033
		9/21/94	<0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	0.9	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/16/94	0.0006	0.007	<0.1	0.0006	<0.05	<0.1	0.9	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	0.0009	0.006	<0.1	<0.0002	<0.05	<0.1	0.8	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-05	Kelly Creek Spring	11/16/95	<0.003	<0.04	0.046	<0.0024	<0.005	<0.003	1.10	<0.024	<0.0002	0.0430	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	0.04	0.103	<0.002	<0.003	<0.003	1.20	0.134	<0.0002	1.38	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.067	<0.002	<0.003	<0.003	0.88	0.063	<0.0002	0.124	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.049	<0.002	<0.003	<0.003	0.90	<0.017	<0.0002	0.115	<0.04	<0.018	<0.001	<0.002

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SPG-05	Kelly Creek	11/30/94	8.10	6.6	269	176	155	54.9	8.5	44.6	10.7	30.8	31.6	0.76	<0.3
(cont.)	Spring	9/21/94	8.38	17.9	343	177	138	52.0	12.0	37.0	11.0	30.0	28.0	0.2	<0.1
		6/15/94	7.28	21.4	474	256	183	63.0	37.0	52.0	13.0	42.0	27.0	0.3	<0.1
		3/8/94	8.70	14.7	301	172	121	50.0	7.4	34.0	8.8	30.0	32.0	0.1	0.8
SPG-07	Alkali Spring	11/14/95	9.16	17.1	1320	1110	2	614	2.53	0.65	0.094	47.3	99.6	n/a	<0.078
		8/8/95	9.21	16.7	1420	1130	2	586	3.54	0.73	0.129	47.7	98.4	0.05	0.091
		5/31/95	9.10	17.9	1410	1130	3	612	3.87	0.79	0.157	46.9	93.9	<0.02	<0.082
		3/22/95	9.20	11.6	1440	1170	3	655	4.08	1.18	0.134	51.0	106	<0.02	<0.082
		11/29/94	9.10	17.1	1400	1330	2	656	3.5	0.69	0.12	48.5	98.1	<0.005	<0.3
		9/22/94	9.07	18.4	1508	1066	2	650	4.0	0.6	0.1	47.0	100	<0.1	<0.1
		6/18/94	9.16	28.3	1468	1086	2	660	5.7	0.7	0.1	49.0	100	<0.1	<0.1
		3/10/94	9.12	15.7	1523	1153	<1	618	8.2	<0.1	<0.1	48.0	114	<0.1	<0.1
SPG-08	NW of	11/14/95	7.73	14.3	288	181	159	41.4	4.30	50.3	8.03	23.7	26.8	n/a	<0.078
	Hammond Ranch	8/8/95	8.12	26.9	317	179	152	38.4	4.44	48.6	7.47	21.8	28.1	0.71	<0.082
		5/31/95	7.89	22.5	311	190	166	40.5	6.01	53.1	8.07	24.4	23.0	0.69	<0.082
		3/21/95	7.90	10.4	282	171	154	39.3	3.11	49.4	7.46	23.0	24.3	0.73	0.104
		11/30/94	7.90	11.7	255	161	148	41.1	4.20	47.3	7.38	20.2	21.4	0.81	<0.3
		6/16/94	8.36	24.3	265	150	113	39.0	5.10	35.0	6.3	21.0	22.0	0.1	<0.1
		3/11/94	7.81	8.7	300	159	142	40.0	4.00	45.0	7.2	21.0	26.0	1.1	0.5
SPG-09	East of	11/14/95	8.46	21.4	263	131	67	60.0	3.14	21.1	3.46	16.2	26.5	n/a	<0.078
	Hot Springs Rn.	8/9/95	8.17	25.7	291	133	67	56.6	3.63	21.3	3.49	15.7	25.8	0.29	<0.082
		5/31/95	8.14	25.3	273	141	71	59.7	3.95	22.5	3.65	17.7	26.8	0.26	<0.082
		3/22/95	8.30	13.1	248	139	71	64.1	3.62	22.1	3.78	17.0	26.5	0.26	<0.082
		9/22/94	7.95	20.7	285	135	67	58.0	3.8	21.0	3.6	16.0	25.0	0.2	<0.1
		6/17/94	8.49	23.7	291	136	63	56.0	4.2	20.0	3.2	16.0	25.0	0.2	<0.1
		3/10/94	7.81	16.3	275	122	68	61.0	4.3	21.0	3.7	19.0	32.0	0.3	0.7
SPG-11	Barite Mine Spg.	11/14/95	7.72	15.4	321	183	226	33.3	0.93	63.0	16.6	34.3	54.8	n/a	<0.078
	(Christison)	8/8/95	7.90	15.8	305	180	220	30.8	1.51	61.3	16.3	33.1	55.0	0.24	<0.082
		5/31/95	7.79	15.2	326	180	233	33.9	1.55	65.0	17.3	36.2	53.4	0.35	<0.082
		3/30/95	7.80	12.8	248	174	243	33.7	1.87	68.8	17.4	35.6	55.9	0.38	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SPG-05	Kelly Creek	11/30/94	<0.004	<0.04	0.054	<0.004	<0.004	0.004	0.9	0.091	<0.0002	0.178	<0.04	<0.02	<0.001	<0.004
(cont.)	Spring	9/21/94	<0.0005	0.011	<0.1	<0.0002	<0.05	<0.1	1.2	<0.1	<0.0005	0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0013	0.017	0.2	0.0011	<0.05	<0.1	1.0	<0.1	<0.0005	1.4	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0008	0.012	<0.1	<0.0002	<0.05	<0.1	0.8	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-07	Alkali Spring	11/14/95	<0.003	0.59	0.060	<0.0024	<0.005	<0.003	17.9	<0.024	<0.0002	0.0010	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	0.60	0.052	<0.002	<0.003	<0.003	15.4	<0.017	<0.0002	0.0030	<0.001	<0.001	<0.041	0.002
		5/31/95	<0.002	0.63	0.060	<0.002	<0.003	<0.003	15.0	<0.017	<0.0002	0.0041	<0.04	<0.018	0.001	<0.002
		3/22/95	<0.002	0.74	0.057	<0.002	<0.003	<0.003	16.1	<0.017	<0.0002	0.0030	<0.04	<0.018	<0.001	<0.002
		11/29/94	<0.004	0.64	0.064	<0.004	<0.004	<0.003	17.8	<0.009	<0.0002	0.003	<0.04	<0.02	<0.001	<0.004
		9/22/94	<0.0012	0.57	<0.1	<0.0002	<0.05	<0.1	18.0	<0.1	<0.0005	<0.1	0.010	<0.5	<0.001	<0.1
		6/18/94	0.0080	0.60	<0.1	0.0064	<0.05	<0.1	18.0	<0.1	<0.0005	<0.1	0.0016	<0.5	<0.001	<0.1
		3/10/94	0.0048	0.78	<0.1	<0.0002	<0.05	<0.1	18.0	<0.1	<0.0005	<0.1	0.0038	<0.5	<0.001	<0.1
SPG-08	NW of	11/14/95	<0.003	<0.04	0.042	<0.0024	<0.005	<0.003	1.10	0.059	<0.0002	0.2160	<0.001	<0.001	<0.04	<0.002
	Hammond Ranch	8/8/95	<0.002	<0.04	0.031	<0.002	<0.003	<0.003	1.00	0.035	<0.0002	0.128	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.047	<0.002	<0.003	<0.003	0.99	0.122	<0.0002	0.254	<0.04	<0.018	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.030	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.043	<0.04	<0.018	<0.001	<0.002
		11/30/94	<0.004	<0.04	0.041	<0.004	<0.004	<0.003	0.89	0.028	<0.0002	0.131	<0.04	<0.02	<0.001	<0.004
		6/16/94	0.0005	0.011	<0.1	0.0004	<0.05	<0.1	1.0	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	0.0006	0.007	<0.1	<0.002	<0.05	<0.1	0.8	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-09	East of	11/14/95	<0.003	<0.04	0.004	<0.0024	<0.005	<0.003	4.70	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
	Hot Springs Rn.	8/9/95	<0.002	<0.04	0.004	<0.002	0.003	<0.003	4.40	<0.017	<0.0002	0.004	<0.001	<0.001	<0.041	0.002
		5/31/95	<0.002	<0.04	0.005	<0.002	0.0036	<0.003	5.06	0.076	<0.0002	0.0023	<0.04	<0.018	<0.010	<0.002
		3/22/95	<0.002	<0.04	0.005	<0.002	0.003	<0.003	5.10	<0.017	<0.0002	0.001	<0.04	<0.018	<0.001	<0.002
		9/22/94	<0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	4.6	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0007	<0.005	<0.1	0.0005	<0.05	<0.1	4.7	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/10/94	0.0007	0.005	<0.1	<0.0002	<0.05	<0.1	4.4	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-11	Barite Mine Spg.	11/14/95	<0.003	<0.04	0.064	<0.0024	<0.005	<0.003	1.00	<0.024	<0.0002	0.0010	<0.001	<0.001	<0.04	0.002
	(Christison)	8/8/95	<0.002	<0.04	0.053	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.004	<0.001	<0.001	<0.041	0.003
		5/31/95	<0.002	<0.04	0.0617	<0.002	<0.003	<0.003	1.06	<0.017	<0.0002	<0.001	<0.04	<0.018	<0.001	<0.002
		3/30/95	<0.005	<0.04	0.0646	<0.005	<0.003	<0.010	1.04	<0.050	<0.0002	0.0037	<0.04	<0.018	0.0010	<0.005

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SPG-11	Barite Mine Spg.	9/21/94	7.79	17.6	336	175	232	32.0	1.8	65.0	17.0	34.0	57.0	0.3	<0.1
(cont.)	(Christison)	6/17/94	7.83	16.8	238	178	218	31.0	1.8	61.0	16.0	36.0	58.0	0.3	<0.1
		4/1/94	7.93	14.8	314	175	211	28.0	1.5	60.0	15.0	36.0	55.0	0.3	<0.1
SPG-12	Corral Spring	11/14/95	7.67	16.8	253	173	199	24.7	2.58	56.8	13.9	17.5	51.6	n/a	<0.078
	(Christison)	8/8/95	7.74	18.8	278	173	201	23.8	3.04	57.3	14.1	17.6	51.2	<0.02	<0.082
		5/31/95	7.60	18.1	283	174	207	25.3	2.69	59.1	14.4	18.1	48.3	<0.02	<0.082
		3/30/95	7.60	16.2	191	170	216	25.7	3.12	62.5	14.6	17.0	50.5	<0.02	<0.082
		9/22/94	7.56	19.3	308	165	202	23.0	2.9	58.0	14.0	16.0	52.0	<0.1	<0.1
		6/17/94	7.63	21.4	311	172	191	24.0	3.2	55.0	13.0	16.0	52.0	<0.1	<0.1
		4/1/94	8.03	16.7	285	170	184	20.0	2.6	54.0	12.0	18.0	48.0	0.4	<0.1
SPG-13	Layton Spring	11/16/95	7.64	15.0	220	82.3	97	25.4	3.26	34.2	2.87	20.7	30.0	n/a	0.081
		8/9/95	7.53	16.3	210	82.7	95	23.6	3.36	33.4	2.79	20.0	27.5	0.92	<0.082
		5/31/95	7.89	16.6	228	90.6	102	25.1	3.44	36.0	2.99	21.4	34.2	0.87	<0.082
		3/22/95	7.70	13.0	217	82	102	26.2	3.4	35.8	3.05	22.0	36.2	0.96	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SPG-11	Barite Mine Spg.	9/21/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	1.0	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
(cont.)	(Christison)	6/17/94	0.0006	<0.005	<0.1	0.0005	<0.05	<0.1	1.0	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		4/1/94	0.0006	<0.005	<0.1	<0.0002	<0.05	<0.1	0.8	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-12	Corral Spring	11/14/95	<0.003	<0.04	0.065	<0.0024	<0.005	<0.003	0.30	0.129	<0.0002	0.0050	<0.001	<0.001	<0.04	<0.002
	(Christison)	8/8/95	<0.002	<0.04	0.058	<0.002	<0.003	<0.003	0.40	0.129	<0.0002	0.006	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.0658	0.0022	<0.003	<0.003	0.34	0.153	<0.0002	0.0069	<0.04	<0.018	<0.001	<0.002
		3/30/95	<0.005	<0.04	0.0679	<0.005	<0.003	<0.010	0.40	0.116	<0.0002	0.0094	<0.04	<0.018	<0.001	<0.005
		9/22/94	<0.0005	0.011	<0.1	<0.0002	<0.05	<0.1	0.4	0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0005	0.011	<0.1	0.0003	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		4/1/94	0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-13	Layton Spring	11/16/95	<0.003	<0.04	0.023	<0.0024	<0.005	<0.003	2.50	<0.024	<0.0002	0.0020	0.001	<0.001	<0.04	<0.002
		8/9/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	2.40	<0.017	<0.0002	0.001	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.026	<0.002	<0.003	<0.003	2.74	0.024	<0.0002	0.0301	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.024	<0.002	<0.003	<0.003	2.80	<0.017	<0.0002	0.002	<0.04	<0.018	<0.001	<0.002

Source: WESTEC 1995b

TBA-1.XLS

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
Pit dewatering wells, drains, and seeps																					
DW-05	in pit	Pu	500	433	12/5/94	7.50	25.1	220	170	198	29.3	4.1	47.1	19.6	15.2	46.8	<0.02	<0.3	<0.004	**0.280**	0.072
					9/22/94'	7.71	26.6	261	169.8	191	26.9	3.71	45.4	18.8	16.3	47.4	N.A.	<0.057	<0.002	**0.244**	0.0667
					8/29/94	7.88	27.5	286	165	168	25	3.3	41	16.0	16	49	<0.1	<0.1	<0.0005	**0.220**	<0.1
					6/8/94	7.72	26.6	264	163	181	26	4.3	43	18.0	17	48	<0.1	<0.1	<0.0005	**0.310**	<0.1
DW-06	in pit	Pu	400	617	11/2/95	7..57	24.7	239	176	190	29.4	4.2	46.5	17.9	12.6	49.7	<0.02	<0.078	<0.003	**0.88**	0.068
					7/31/95	7.70	25.5	232	176	184	26.3	3.99	44.6	17.6	12.9	50.8	<0.02	<0.082	<0.002	**0.91**	0.060
					5/18/95	7.76	24.3	243	176	195	27.1	3.98	48.7	17.9	12.1	49.7	<0.02	<0.082	<0.002	**1.02**	0.0686
					3/13/95	7.70	23.7	229	178	188	27.0	4.02	45.7	18.0	12.7	50.2	<0.02	<0.057	<0.002	**0.96**	0.067
					12/22/94	7.60	20.6	238	177	207	29.7	4.2	51.3	19.3	12.5	48.6	0.02	0.06	<0.002	**1.180**	0.076
					9/26/94	7.80	24.0	261	172	189	25	4.0	46	18.0	12	48	<0.1	<0.1	<0.0005	**0.680**	<0.1
					9/20/94'	7.72	24.8	268	173.7	194	26.9	4.33	47.9	18.2	12.7	48.4	N.A.	<0.057	<0.002	**0.788**	0.0688
					6/8/94	7.69	23.6	259	170	182	26	4.7	45	17.0	12	50	<0.1	<0.1	<0.0005	**0.940**	<0.1
					3/30/94	8.01	23.8	264	168	183	23	4.3	47	16.0	15	48	<0.1	<0.1	0.0006	**1.100**	<0.1
DW-07	in pit	Pu	500 & 200	786	10/2/95	7.58	24.1	256	168	182	22.5	3.93	43.6	17.7	18.2	44.6	0.03	<0.082	<0.002	**0.25**	0.054
					8/5/95	7.81	24.6	N.A.	167	197	26.6	3.98	46.7	19.6	18.1	46.1	<0.02	0.087	<0.002	**0.22**	0.054
					5/18/95	7.84	24.3	211	167	195	25.8	4.33	46.5	19.2	18.1	45.4	0.040	<0.082	<0.002	**0.249**	0.0584
					12/22/94	7.60	19.4	230	168	209	29.1	3.7	50	20.5	18.3	45.3	0.05	0.07	<0.002	**0.280**	0.064
					9/21/94'	7.65	23.5	256	155.7	192	25.4	3.95	45.9	18.9	19.1	45.2	N.A.	0.04	<0.002	**0.258**	0.0576
					9/13/94	8.02	21.8	272	162	190	25	4.2	45	19.0	19	45	0.10	<0.1	<0.0005	**0.270**	<0.1
					6/6/94	7.88	18.8	267	160	175	25	4.8	42	17.0	19	45	<0.1	<0.1	<0.0005	**0.270**	<0.1
					3/29/94	8.11	19.5	272	163	185	23	4.1	46	17.0	22	50	0.20	<0.1	0.0006	**0.290**	<0.1
DW-08	in pit	Pu	500 & 200	785	10/3/95	7.66	26.2	255	174	182	24.3	3.89	43.6	17.7	15.7	48.0	0.05	<0.082	<0.002	**0.27**	0.063
					8/11/95	7.61	26.7	239	174	186	26.4	3.8	44.1	18.4	15.9	48.2	0.02	0.200	<0.0022	**0.249**	0.0611
					12/5/94	7.60	24.5	293	175	208	29.4	4.4	49.4	20.7	18.6	47.3	0.03	<0.3	<0.004	**0.320**	0.075
					9/20/94'	7.84	24.9	276	171.2	195	26.7	4.08	46.3	19.3	19.8	46.2	0.05	0.020	<0.002	**0.273**	0.0689
					8/29/94	8.05	22.6	287	165	177	25	3.5	43	17.0	20	50	<0.1	<0.1	<0.0005	**0.310**	<0.1
					6/8/94	8.09	26.4	275	166	184	27	4.6	44	18.0	22	50	<0.1	<0.1	<0.0005	**0.340**	<0.1
DW-09	in pit	Pu		340	10/3/95	7.71	19.0	294	174	208	25.4	4.59	48.4	21.1	26.5	57.7	<0.01	<0.082	<0.002	**0.32**	0.038
					8/11/95	7.54	19.1	270	171	215	27.8	3.96	48.8	22.7	28.3	58.9	0.59	0.100	<0.0022	**0.212**	0.0406
DW-10	in pit	Pu	500	880	10/9/95	7.66	25.4	259	173	199	25.4	4.72	46.1	20.4	20.2	49.8	<0.01	<0.082	<0.002	**0.30**	0.068
					8/16/95	7.79	25.6	241	172	190	27.2	4.29	43.7	19.8	20.1	47	0.03	<0.082	<0.002	**0.29**	0.069
					3/13/95'	7.90	23.1	253	173	191	26.6	4.45	43.4	20.2	22	47.3	0.04	<0.057	<0.002	**0.31**	0.0640
					12/22/94	7.80	19.2	243	170	207	28.4	5.3	48.3	21.0	22	47.1	0.11	0.07	<0.002	**0.310**	0.062
					9/13/94	8.00	22.8	282	164	199	26	5.3	45	21.0	23	48	0.20	0.2	<0.0005	**0.400**	<0.1
DW-11	in pit	Pu		1165	10/3/95	7.72	20.6	238	160	176	21.8	3.29	39.1	19.0	23.1	37.6	0.02	<0.082	<0.002	**0.23**	0.066
					7/31/95	7.96	21.1	216	159	173	23.9	3.45	38.3	18.8	22.9	40.5	0.17	0.532	<0.002	**0.27**	0.061
DW-13	in pit	Pu		780	10/2/95	7.66	18.0	286	164	201	24.8	4.27	45.1	21.5	29.6	55.9	<0.01	<0.082	<0.002	**0.37**	0.039
					8/11/95	7.51	20.8	270	164	206	27.2	3.88	46.2	22.1	27.5	56.6	0.66	0.100	<0.0022	**0.329**	0.0449
					6/1/95	7.67	17.9	291	159	219	28.3	3.96	49.4	23.4	30.6	57.4	0.83	0.087	<0.002	**0.34**	0.050

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
Pit dewatering wells, drains, and seeps																		
DW-05	in pit	Pu	500	433	12/5/94	0.15	<0.004	<0.004	<0.003	0.58	0.122	0.0003	0.023	<0.02	**<0.04**	**0.070**	<0.001	0.009
					9/22/94'	N.A	<0.002	<0.004	<0.002	0.56	0.173	<0.0002	0.024	<0.1	<0.001	**0.052**	<0.001	<0.004
					8/29/94	0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/8/94	0.1	<0.0002	<0.05	<0.1	0.61	**0.4**	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
DW-06	in pit	Pu	400	617	11/2/95	0.114	<0.0024	<0.005	<0.003	0.60	0.047	<0.0002	0.037	<0.017	<0.001	**0.024**	<0.04	0.004
					7/31/95	0.157	0.002	<0.003	<0.003	0.6	0.128	<0.0002	0.037	<0.021	0.002	**0.013**	<0.041	0.003
					5/18/95	0.148	<0.002	<0.003	0.0037	0.58	0.143	<0.0002	0.038	<0.021	**<0.04**	**0.022**	<0.001	0.0144
					3/13/95	0.154	<0.002	<0.004	<0.002	0.70	0.125	<0.0002	0.037	<0.01	**<0.04**	**0.026**	<0.001	<0.004
					12/22/94	0.021	<0.002	<0.004	<0.002	0.60	**0.388**	<0.0002	**0.064**	<0.01	**<0.04**	**<0.02**	<0.001	0.011
					9/26/94	0.2	<0.0002	<0.05	<0.1	0.60	0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
					9/20/94'	N.A.	<0.002	<0.004	<0.002	0.56	0.136	<0.0002	0.0466	<0.01	<0.001	**<0.024**	<0.001	0.0099
					6/8/94	0.1	<0.0002	<0.05	<0.1	0.69	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/30/94	0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
DW-07	in pit	Pu	500 & 200	786	10/2/95	0.072	<0.002	<0.003	<0.003	0.60	0.068	<0.0002	0.031	<0.021	<0.001	**0.03**	<0.041	0.003
					8/5/95	0.096	<0.002	<0.003	<0.003	0.5	0.021	<0.0002	0.035	<0.021	<0.001	**0.033**	<0.041	0.015
					5/18/95	0.143	<0.002	<0.003	<0.003	0.57	0.063	<0.0002	0.0312	<0.021	**<0.04**	**0.048**	<0.001	0.0065
					12/22/94	0.18	<0.002	<0.004	<0.002	0.60	0.055	<0.0002	0.03	<0.01	**<0.04**	**0.03**	<0.001	<0.004
					9/21/94'	N.A.	<0.002	<0.004	<0.002	0.55	0.0669	<0.0002	0.0283	<0.01	<0.001	**0.049**	<0.001	<0.004
					9/13/94	0.2	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/6/94	0.1	<0.0002	<0.05	<0.1	0.57	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/29/94	0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
DW-08	in pit	Pu	500 & 200	785	10/3/95	0.080	<0.002	<0.003	<0.003	0.60	0.061	<0.0002	0.020	<0.021	<0.001	**0.053**	<0.041	0.004
					8/11/95	0.158	<0.0019	<0.002	<0.0017	0.6	0.101	0.0003	0.0266	<0.0069	<0.001	**0.079**	**<0.061**	0.0031
					12/5/94	0.17	<0.004	<0.004	<0.003	0.61	0.013	0.0008	0.02	<0.02	**<0.04**	**0.080**	<0.001	<0.004
					9/20/94'	N.A.	<0.002	<0.004	<0.002	0.66	0.0495	0.00116	0.0244	<0.01	<0.001	**0.068**	<0.001	<0.004
					8/29/94	0.1	<0.0002	<0.05	<0.1	0.70	<0.1	0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/8/94	0.1	<0.0002	<0.05	<0.1	0.67	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
DW-09	in pit	Pu		340	10/3/95	0.083	<0.002	<0.003	0.004	0.60	0.042	0.0009	0.029	<0.021	<0.001	**0.006**	<0.041	0.069
					8/11/95	0.154	<0.0019	<0.002	<0.0017	0.5	**0.349**	0.0006	0.0241	<0.0069	<0.001	<0.001	**<0.061**	0.111
DW-10	in pit	Pu	500	880	10/9/95	0.158	<0.002	<0.003	<0.003	0.60	<0.017	0.0004	0.019	<0.021	0.001	**0.023**	<0.041	0.003
					8/16/95	0.133	<0.002	<0.003	<0.003	0.6	0.021	0.0004	0.019	<0.021	<0.001	**0.081**	<0.041	0.008
					3/13/95'	N.A.	<0.002	<0.004	<0.002	0.70	0.015	0.0005	0.005	<0.01	**<0.04**	**0.061**	<0.001	<0.004
					12/22/94	0.2	<0.002	<0.004	<0.002	0.60	0.009	0.0007	0.002	<0.01	**<0.04**	**0.060**	0.002	0.005
					9/13/94	0.2	<0.0002	<0.05	<0.1	0.60	<0.1	0.0010	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
DW-11	in pit	Pu		1165	10/3/95	0.046	<0.002	<0.003	<0.003	0.60	0.036	<0.0002	0.008	<0.001	<0.001	**0.035**	**0.051**	0.011
					7/31/95	0.118	<0.002	<0.003	<0.003	0.70	0.069	<0.0002	0.026	<0.001	0.002	**0.039**	<0.041	0.01
DW-13	in pit	Pu		780	10/2/95	0.082	<0.002	0.004	<0.003	0.70	0.022	<0.0002	0.004	<0.021	<0.001	<0.001	**0.056**	0.038
					8/11/95	0.154	<0.0019	<0.002	<0.0017	0.6	0.0202	<0.0002	0.0069	<0.0069	<0.001	**0.009**	**<0.061**	0.0642
					6/1/95	0.132	<0.002	<0.003	<0.003	0.60	0.055	<0.0002	0.007	<0.021	**<0.04**	**<0.018**	0.007	0.155

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
DW-14	in pit	Pu		780	10/3/95	7.97	18.1	229	157	175	20.2	4.45	37.9	19.5	20.2	38.0	<0.01	<0.082	0.003	**0.19**	0.043
					8/5/95	7.84	17.5	218	152	182	23.8	3.73	40	20	20.5	36.5	<0.02	<0.082	<0.002	**0.13**	0.035
DW-15	in pit	Pu		780	10/3/95	7.71	16.9	251	140	171	23.4	3.63	39.3	17.8	30.7	47.7	0.05	<0.082	0.003	**0.15**	0.067
					7/31/95	7.90	17.2	238	139	164	25	3.12	36.9	17.5	29.2	42.8	0.38	<0.082	<0.002	**0.14**	0.060
DW-16	in pit	Pu		1160	10/3/95	7.71	18.1	229	152	163	21.4	4.24	37.1	17.1	25.0	33.3	<0.01	<0.082	0.002	**0.22**	0.063
					7/31/95	7.91	17.9	196	149	161	23.4	3.56	36.1	17.2	24.2	35.7	0.37	<0.082	<0.002	**0.21**	0.064
DW-17	south of pit				10/3/95	7.82	17.2	220	142	146	21.1	3.27	33.6	15.1	16.8	22.9	<0.01	<0.082	<0.002	**0.10**	0.062
Drain 1 East	in pit-cut 6	Pu			9/15/94	8.00	23.5	275	173	190	25	3.9	45	19.0	19	48	0.20	<0.1	<0.0005	**0.360**	<0.1
Drain 2	in pit-cut 6	Pu			9/15/94	7.75	25.2	278	165	192	25	4.0	44	20.0	18	48	0.30	<0.1	<0.0005	**0.550**	<0.1
Drain 3	in pit-cut 6	Pu			9/15/94	8.20	25.1	274	165	183	27	3.8	42	19.0	14	47	<0.1	<0.1	<0.0005	**0.290**	<0.1
Drain 4	in pit-cut 6	Pu			9/15/94	8.32	25.9	271	168	183	27	4.0	42	19.0	14	47	<0.1	<0.1	<0.0005	**0.380**	<0.1
Drain 5 West	in pit-cut 6	Pu			9/15/94	7.88	17.4	370	167	255	31	4.7	61	25.0	28	96	0.40	<0.1	<0.0005	**0.980**	<0.1
Bedrock Drain	in pit	Pu			6/8/94	8.26	24.4	299	164	207	26	4.6	50	20.0	25	62	0.22	<0.1	<0.0005	**0.480**	<0.1
					3/28/94	7.82	19.9	264	166	220	25	4.2	55	20.0	26	51	0.30	<0.1	0.0006	**0.640**	<0.1
Lower Drain	in pit	Pu			6/8/94	8.36	20.1	297	171	209	27	4.8	46	23.0	15	84	<0.1	<0.1	<0.0005	**0.070**	<0.1
					3/28/94	8.25	22.3	282	164	194	23	3.7	48	18.0	27	47	0.20	<0.1	0.0006	**0.530**	<0.1
North Seep	in pit	Pu	400		10/12/94'	8.29	N.A.	290	175	218	29.7	4.47	50.7	22.2	31.4	63.7	0.22	0.29	<0.002	**0.842**	0.0465
Pit Sump	in pit	Pu			10/9/95	7.96	16.6	365	186	276	27.5	3.65	65.9	27.2	12.6	115.0	<0.02	0.380	<0.002	**1.04**	0.049
					7/31/95	8.35	27.3	305	178	229	25.5	3.65	51.6	24.3	12.3	89.6	<0.02	<0.082	<0.002	**0.34**	0.0450
					5/18/95	8.25	22.3	253	162	211	26.6	4.07	49.5	21.3	18.3	72.7	0.220	<0.082	0.0021	**0.326**	0.0506
					3/13/95	8.30	19.8	256	170	193	25.0	3.77	44.2	20.1	17.5	65.9	0.13	<0.057	<0.002	**0.28**	0.0550
SE Drain	in pit	Pu	400		9/21/94'	7.84	N.A.	268	169	195	26.1	4.27	45.8	19.7	18.6	46.7	N.A.	<0.057	<0.002	**0.323**	0.0728
South Seep	in pit	Pu	400		9/21/94'	8.24	N.A.	266	169	189	27.8	3.85	44.4	19.1	14.1	46.8	0.03	<0.057	<0.002	**0.284**	0.0697
Monitoring Wells																					
Dudley Well	S of Midas Road	QTar	100	60	7/14/94	7.68	16.4	**620**	91	216	140	8.4	70	10.1	170	150	0.90	<0.1	<0.0005	0.047	<0.1
GFW-1	well sheds SE of S. Admin	QTal	100	424	5/17/95	8.09	20.4	200	119	104	31.1	5.03	28.3	8.09	16.9	23.9	0.210	<0.082	<0.002	<0.040	0.005
					2/26/95	8.00	19.6	224	120	97	30.7	5.34	26.5	7.53	17.0	22.8	0.17	<0.057	<0.002	<0.04	0.005
					12/5/94	7.80	12.1	152	120	91	34.9	6.3	26.3	6.19	13.5	18	0.14	<0.3	<0.004	<0.04	0.01
					9/13/94	7.94	18.1	226	117	84	32	5.9	24	5.9	14	18	0.20	<0.1	<0.0005	0.016	<0.1
					9/21/94'	8.00	18.4	229	123	100	30.5	5.11	27.3	7.75	16	20.7	N.A.	0.123	<0.002	0.01	0.0063
					6/9/94	7.99	20.1	231	110	91	29	5.4	25	7.0	15	20	0.20	<0.1	0.0005	0.013	<0.1
GFW-2	well sheds SE of S. Admin	QTal	100	755	5/17/95	8.02	18.3	199	121	88	33.3	6.94	25.4	5.95	14.2	17.4	0.070	0.083	<0.002	<0.040	0.0107
					2/26/95	7.90	16.3	208	121	84	32.8	6.38	24.1	5.68	13.7	16.3	<0.02	<0.057	<0.002	<0.04	0.008
					12/5/94	7.90	13.1	193	121	91	34.6	6.8	26.2	6.18	13.9	17.5	0.09	<0.3	<0.004	<0.04	0.01
					9/26/94'	8.06	18.1	204	109	83	30	5.7	24	5.7	13	18	0.20	<0.1	<0.0005	0.019	<0.1
					6/9/94	7.84	20.0	230	115	80	31	6.3	23	5.5	13	18	0.20	<0.1	<0.0005	0.016	<0.1
GW-1	SW of leach pad J	QTal	100	521	9/23/94'	7.61	24.4	N.A.	144	155	27.4	5.47	37.7	14.9	20.3	33.8	N.A.	0.1	<0.002	**0.065**	0.0923
GW-2	E of leach pad K	QTal	100	291	10/12/94'	7.80	18.1	327	144	151	24.6	3.64	38.6	13.4	19.2	28.8	1.54	0.057	0.0024	0.018	0.0761
GW-3	E of tailings A	QTal	100	275	10/12/94'	7.86	14.0	228	146	108	45.2	6.23	30.7	7.56	21.4	28.8	1.67	0.085	<0.002	0.011	0.031
GW-4	E of leach pad K	QTal	100	300	9/23/94'	7.64	15.0	N.A.	140	155	23.9	4.54	38.6	14.3	16.1	32.3	N.A.	0.1	<0.002	0.013	0.0594

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
DW-14	in pit	Pu		780	10/3/95	0.061	<0.002	0.005	0.005	0.60	<0.017	<0.0002	0.010	<0.021	<0.001	**0.009**	<0.041	0.092
					8/5/95	0.080	<0.002	<0.003	<0.003	0.6	<0.017	0.0007	0.014	<0.021	<0.001	**0.007**	<0.041	0.166
DW-15	in pit	Pu		780	10/3/95	0.039	<0.002	0.005	<0.003	0.50	0.037	<0.0002	0.004	<0.021	<0.001	**0.001**	<0.041	0.02
					7/31/95	0.110	<0.002	0.003	<0.003	0.6	0.05	<0.0002	0.006	<0.021	<0.001	0.001	<0.041	0.034
DW-16	in pit	Pu		1160	10/3/95	0.048	<0.002	0.004	<0.003	0.60	0.04	<0.0002	0.006	<0.021	<0.001	**0.054**	<0.041	0.018
					7/31/95	0.113	<0.002	<0.003	<0.003	0.6	0.032	<0.0002	0.007	<0.021	0.003	**0.041**	<0.041	0.056
DW-17	south of pit				10/3/95	0.126	<0.002	0.005	<0.003	0.50	<0.017	<0.0002	0.009	<0.021	<0.001	**0.003**	<0.041	0.07
Drain 1 East	in pit-cut 6	Pu			9/15/94	0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
Drain 2	in pit-cut 6	Pu			9/15/94	0.2	<0.0002	<0.05	<0.1	0.70	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
Drain 3	in pit-cut 6	Pu			9/15/94	0.2	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
Drain 4	in pit-cut 6	Pu			9/15/94	0.2	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
Drain 5 West	in pit-cut 6	Pu			9/15/94	0.2	<0.0002	<0.05	<0.1	0.80	<0.1	0.0005	<0.1	<0.1	<0.002	**<0.5**	0.005	<0.1
Bedrock Drain	in pit	Pu			6/8/94	0.1	<0.0002	<0.05	<0.1	0.63	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	0.002	<0.1
					3/28/94	0.1	<0.0002	<0.05	<0.1	0.60	<0.1	0.0014	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
Lower Drain	in pit	Pu			6/8/94	0.1	<0.0002	<0.05	<0.1	0.53	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	0.001	<0.1
					3/28/94	0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	0.001	<0.1
North Seep	in pit	Pu	400		10/12/94[1]	N.A.	<0.002	<0.004	0.0076	0.762	<0.006	<0.0002	0.0196	<0.01	0.001	**<0.024**	<0.001	<0.004
Pit Sump	in pit	Pu			10/9/95	0.164	<0.002	<0.003	<0.003	0.70	<0.017	<0.0002	**0.142**	<0.021	<0.001	**0.012**	<0.041	<0.002
					7/31/95	0.135	<0.002	<0.003	<0.003	0.6	<0.017	<0.0002	**0.053**	<0.021	0.001	**0.055**	<0.041	<0.002
					5/18/95	0.154	<0.0020	<0.003	<0.003	0.65	<0.017	<0.0002	0.049	<0.021	**<0.04**	**<0.018**	<0.001	<0.002
					3/13/95	0.128	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	0.027	<0.01	**<0.04**	**0.025**	<0.001	<0.004
SE Drain	in pit	Pu	400		9/21/94[1]	N.A.	<0.002	<0.004	<0.002	0.61	<0.006	0.00034	**0.0565**	<0.01	0.001	**0.024**	<0.001	<0.004
South Seep	in pit	Pu	400		9/21/94[1]	N.A.	<0.002	<0.004	<0.002	0.59	<0.006	<0.0002	0.0213	<0.01	<0.001	**<0.024**	<0.001	<0.004
Monitoring Wells																		
Dudley Well	S of Midas Road	QTar	100	60	7/14/94	0.23	<0.0002	<0.05	<0.1	0.90	<0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
GFW-1	well sheds SE of S. Admin	QTal	100	424	5/17/95	0.112	<0.002	<0.003	<0.003	0.56	<0.017	<0.0002	<0.0010	<0.021	**<0.04**	**<0.018**	<0.001	<0.002
					2/26/95	0.064	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.010	<0.004
					12/5/94	0.1	<0.004	<0.004	<0.003	0.56	<0.009	<0.0002	0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/13/94	<0.1	<0.0002	<0.05	<0.1	0.60	0.1	<0.0005	<0.1	<0.1	<0.002	**<0.5**	<0.001	<0.1
					9/21/94[1]	N.A.	<0.002	<0.004	<0.002	0.059	<0.006	<0.0002	<0.002	<0.01	0.002	**<0.024**	<0.001	<0.004
					6/9/94	<0.1	0.0003	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
GFW-2	well sheds SE of S. Admin	QTal	100	755	5/17/95	0.107	<0.002	<0.003	<0.003	0.55	<0.017	<0.0002	0.0053	<0.021	**<0.04**	**<0.018**	<0.001	<0.002
					2/26/95	0.074	<0.002	<0.004	<0.002	0.60	0.020	<0.0002	0.0130	<0.01	**<0.04**	**<0.024**	<0.010	<0.004
					12/5/94	0.090	<0.004	<0.004	<0.003	0.56	<0.009	<0.0002	0.009	<0.02	**<0.04**	**0.024**	<0.001	<0.004
					9/26/94[1]	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.01	<0.002	**<0.5**	<0.001	<0.1
					6/9/94	<0.1	0.0003	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.1	<0.001	**<0.5**	<0.001	<0.1
GW-1	SW of leach pad J	QTal	100	521	9/23/94[1]	N.A.	<0.002	<0.004	<0.002	N.A.	<0.006	<0.0002	<0.002	<0.01	0.003	**<0.024**	0.001	0.494
GW-2	E of leach pad K	QTal	100	291	10/12/94[1]	N.A.	<0.002	<0.004	0.0053	0.656	<0.006	<0.0002	<0.002	0.011	0.004	**<0.024**	<0.001	0.318
GW-3	E of tailings A	QTal	100	275	10/12/94[1]	N.A.	<0.002	<0.004	0.0045	0.625	<0.006	<0.0002	<0.002	<0.01	0.004	**<0.024**	<0.001	0.231
GW-4	E of leach pad K	QTal	100	300	9/23/94[1]	N.A.	<0.002	<0.004	0.0047	N.A.	<0.006	<0.0002	<0.002	<0.01	0.003	**<0.024**	<0.001	0.0113

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
M/Q 384303-1	SW of The Knolls	QTar	100	400	10/6/95	**8.79**	18.2	276	145	20	73.6	5.36	7.42	0.3	13.4	20.5	0.31	1.530	<0.002	**0.06**	<0.001
					8/22/95	**8.77**	20.2	265	140	20	80.5	6.02	7.38	0.278	13.9	20.7	0.32	1.580	<0.002	**0.05**	0.002
					6/15/95	**8.96**	16.4	275	146	19	79.7	5.8	6.92	0.321	14.5	21.2	0.41	1.440	0.005	**0.05**	<0.040
					2/28/95	**9.10**	17.4	278	152	20	86.7	6.16	7.65	0.25	13.0	23.3	0.34	1.290	<0.002	<0.04	0.0030
					11/15/94	**9.30**	20.6	305	158	21	87.6	5.7	8.1	0.19	13.5	24.6	0.36	1.4	<0.004	<0.04	0.004
					9/7/94	**9.77**	21.1	308	168	20	90	5.8	7.8	0.2	14	29	0.40	1.8	<0.0005	0.039	<0.1
					6/10/94	**9.60**	21.1	347	165	21	100	7.7	8.1	0.2	15	42	0.50	<0.1	0.0008	**0.061**	<0.1
					3/22/94	**9.52**	12.0	328	155	32	79	5.0	12	0.5	21	44	0.30	<0.1	0.0012	0.044	<0.1
M/O 384305-1	Infiltration Basin	QTar		160	9/6/96	7.75	N.A.	**899**	69.7	479	94.0	6.55	137	33.3	**324**	88.9	**14.90**	N.A.	0.005	0.002	0.176
					8/15/96	7.76	N.A.	**673**	75.4	360	69.9	4.33	104	24.4	230	85.0	9.99	N.A.	0.008	0.002	0.132
					8/5/96	7.88	N.A.	**708**	77.8	356	70.4	4.86	102	24.6	205	86.0	**10.40**	N.A.	<0.003	0.002	0.131
					7/24/96	7.59	N.A.	**706**	76.8	379	74.1	3.11	109	26.0	224	89.8	**10.10**	N.A.	<0.003	0.001	0.144
					7/8/96	7.57	N.A.	**796**	76.5	404	78.7	4.25	117	27.1	234	92.0	**10.8**	N.A.	<0.003	0.002	0.149
					6/17/96	7.54	N.A.	**827**	74.1	408	73.2	4.68	119	26.9	**252**	93.6	**11.80**	N.A.	<0.003	0.002	0.141
					11/18/95	7.37	13.3	269	101	115	40.2	3.70	34.8	6.82	42.8	33	1.45	0.02	<0.003	0.002	0.041
					7/11/95	7.69	18.0	249	107	115	36.9	3.28	34.7	6.78	42.7	29.1	1.29	N.A.	<0.002	0.003	0.038
					7/5/95	7.79	18.1	264	106	111	38.5	3.67	33.7	6.42	40.7	28.6	1.08	N.A.	<0.002	0.003	0.039
					6/27/95	7.91	18.5	268	105	107	37.5	3.41	32.4	6.23	34.5	27.3	0.78	N.A.	<0.002	0.002	0.036
M/Q 384305-2	Infiltration Basin	QTar		160	7/9/96	7.83	N.A.	240	116	115	31.0	3.17	34.9	6.69	24.1	27.5	0.13	N.A.	0.003	0.002	0.01
					11/18/95	7.43	13.1	246	118	121	31.5	3.83	36.5	7.24	24.3	31.9	0.14	0.01	<0.003	0.001	0.007
					7/11/95	7.66	16.3	224	119	122	28.2	3.51	36.7	7.26	25.7	28.9	0.16	N.A.	<0.002	0.002	0.009
					7/5/95	7.81	16.8	247	118	121	29.7	4.06	36.8	7.13	25.7	28.2	0.14	N.A.	<0.002	0.002	0.009
					6/27/95	7.91	16.3	246	114	122	29.8	3.61	37.1	7.14	25.3	28.5	0.17	N.A.	<0.002	0.001	0.008
M/Q 384305-3	Infiltration Basin	QTar		160	7/9/96	7.87	N.A.	297	150	150	35.6	4.32	48.5	7.08	24.1	35.8	0.47	N.A.	<0.003	<0.001	<0.003
					11/18/95	7.43	12.4	305	160	163	38.8	4.61	52.2	7.84	23.5	40	0.28	0.02	<0.003	<0.001	0.004
					7/11/95	7.56	15.8	295	166	166	33.6	4.69	52.7	8.33	25.2	39.6	0.08	N.A.	<0.002	<0.001	0.006
					7/5/95	7.67	17.4	348	169	174	37.1	5.17	55.4	8.69	25.6	42.7	0.06	N.A.	<0.002	<0.001	0.007
					6/28/95	7.72	15.6	357	160	183	39.3	5.35	58	9.19	23.8	48.5	0.08	N.A.	<0.002	<0.001	0.008
M/Q 384305-4	Infiltration Basin	QTar		140	8/5/96	8.13	N.A.	265	112	127	39.8	5.53	40.0	6.50	47.4	28.2	0.68	N.A.	<0.003	0.003	0.023
					7/9/96	7.98	N.A.	286	112	119	40.8	5.23	38.0	5.97	46.9	27.6	0.67	N.A.	0.004	0.004	0.02
					11/19/95	7.58	13.2	242	118	101	38.6	5.36	32.2	5.12	24.2	30	0.16	0.01	<0.003	0.004	0.017
					7/12/95	8.00	13.3	226	119	101	36.8	4.88	31.8	5.24	26.3	25.4	0.18	N.A.	<0.002	0.003	0.023
					7/6/95	8.00	18.1	234	118	100	36.5	5.30	31.6	5.03	26.3	25.7	0.19	N.A.	<0.002	0.003	0.025
					6/28/95	8.09	-0.7	248	116	99	36.1	5.20	31.4	4.95	25	25.4	0.18	N.A.	<0.002	0.002	0.025
M/Q 384305-5	Infiltration Basin	QTar		140	9/6/96	7.77	N.A.	**980**	84.5	460	106	2.98	133	31.1	**344**	86.6	**14.7**	N.A.	<0.003	0.002	0.161
					8/13/96	7.68	N.A.	**894**	81.9	513	108	2.42	149	34.2	**350**	85.1	**17.3**	N.A.	0.004	0.001	0.182
					8/2/96	7.73	N.A.	**970**	81	480	110	3.12	137	33.5	**361**	84.3	**19.4**	N.A.	<0.003	<0.001	0.17
					7/8/96	7.55	N.A.	**950**	78.8	546	123	2.29	158	36.9	**379**	82.0	**18.2**	N.A.	<0.003	<0.001	0.196
					6/17/96	7.38	N.A.	**1030**	75.4	547	104	2.38	161	35.2	**383**	82.6	**18.1**	N.A.	0.006	0.002	0.177
					6/7/96	6.91	N.A.	**965**	79.5	533	112	2.74	153	36.7	**376**	79.7	**18.1**	N.A.	<0.003	0.001	0.189

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
M/O 384303-1	SW of The Knolls	QTar	100	400	10/6/95	0.221	<0.002	0.003	<0.003	0.70	<0.017	<0.002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					8/22/95	0.209	<0.002	<0.003	<0.003	0.8	0.018	<0.0002	0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					6/15/95	0.240	<0.002	<0.003	<0.003	0.70	0.026	<0.0002	<0.003	<0.021	**<0.04**	**<0.018**	<0.010	<0.002
					2/28/95	0.200	<0.002	<0.004	<0.002	0.70	<0.006	<0.0002	<0.002	0.01	**<0.04**	**<0.024**	<0.010	<0.004
					11/15/94	0.14	<0.004	<0.004	<0.003	0.82	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/7/94	0.20	<0.0002	<0.05	<0.1	0.90	<0.1	<0.0005	<0.1	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/10/94	0.20	0.0009	<0.05	<0.1	1.00	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/22/94	0.20	<0.0002	<0.05	<0.1	1.00	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384305-1	Infiltration Basin	OTar		160	9/6/96	N.A.	<0.0024	0.008	0.004	0.5	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.001	<0.002
					8/15/96	N.A.	0.0025	<0.005	<0.003	0.5	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.005	<0.002
					8/5/96	N.A.	<0.0024	0.007	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.001	<0.002
					7/24/96	N.A.	<0.0024	<0.005	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.003	<0.002
					7/8/96	0.083	<0.0024	<0.005	<0.003	0.5	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					6/17/96	N.A.	<0.0024	<0.005	<0.003	0.5	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.002	<0.002
					11/18/95	0.112	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.017	0.001	N.A.	<0.01	<0.002
					7/11/95	0.107	<0.002	<0.003	0.006	0.40	<0.017	<0.0002	0.004	<0.021	<0.001	N.A.	<0.001	<0.002
					7/5/95	0.102	<0.002	<0.004	0.011	0.50	<0.017	<0.0002	0.002	<0.021	<0.001	N.A.	<0.001	<0.002
					6/27/95	0.090	<0.002	<0.004	<0.003	0.40	<0.017	<0.0002	0.002	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-2	Infiltration Basin	OTar		160	7/9/96	N.A.	<0.0024	<0.005	<0.003	0.4	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					11/18/95	0.076	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.017	<0.001	N.A.	<0.01	<0.002
					7/11/95	0.080	<0.002	<0.003	0.005	0.50	<0.017	<0.0002	0.005	<0.021	<0.001	N.A.	<0.001	<0.002
					7/5/95	0.060	<0.002	<0.004	0.011	0.50	<0.017	<0.0002	0.007	<0.021	<0.001	N.A.	<0.001	<0.002
					6/27/95	0.060	<0.002	<0.004	<0.003	0.40	<0.017	<0.0002	0.009	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-3	Infiltration Basin	QTar		160	7/9/96	N.A.	<0.0024	<0.005	<0.003	0.4	<0.024	<0.0002	0.045	N.A.	<0.001	<0.002	<0.002	<0.002
					11/18/95	0.083	<0.0024	<0.005	<0.003	0.50	<0.024	<0.0002	**0.248**	<0.017	<0.001	N.A.	<0.001	0.011
					7/11/95	0.085	<0.002	<0.003	0.007	0.40	<0.017	<0.0002	**0.037**	<0.021	<0.001	N.A.	<0.001	0.029
					7/5/95	0.078	<0.002	<0.004	0.011	0.40	<0.017	<0.0002	**0.029**	<0.021	<0.001	N.A.	<0.001	0.027
					6/28/95	0.070	<0.002	<0.004	0.011	0.40	<0.017	<0.0002	**0.031**	<0.021	<0.001	N.A.	<0.001	0.034
M/O 384305-4	Infiltration Basin	OTar		140	8/5/96	N.A.	<0.0024	<0.005	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.005	<0.002
					7/9/96	N.A.	0.0027	<0.005	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					11/19/95	0.087	<0.0024	<0.005	<0.003	0.30	<0.024	<0.0002	<0.001	<0.017	<0.001	N.A.	<0.01	<0.002
					7/12/95	0.088	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.004	<0.021	<0.001	N.A.	<0.001	<>0.002
					7/6/95	0.034	<0.002	<0.003	0.004	0.40	<0.017	<0.0002	0.007	<0.021	<0.001	N.A.	0.001	<0.002
					6/28/95	0.070	<0.002	<0.004	0.006	0.30	<0.017	<0.0002	0.008	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-5	Infiltration Basin	OTar		140	9/6/96	N.A.	<0.0024	<0.005	<0.003	0.6	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.001	<0.002
					8/13/96	N.A.	<0.0024	0.007	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.003	<0.002
					8/2/96	N.A.	<0.0024	<0.005	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.005	<0.002
					7/8/96	0.068	<0.0024	<0.005	<0.003	1.0	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					6/17/96	N.A.	<0.0024	<0.005	<0.003	0.7	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.002	<0.002
					6/7/96	0.092	<0.0024	<0.005	<0.003	0.6	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.001	<0.002

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
M/O 384305-5 (Cont.)	Infiltration Basin	QTar		140	11/19/95	6.90	12.7	**1260**	48.6	624	92	5.69	185	39.30	**505**	29.3	**16.50**	0.01	<0.003	<0.001	0.112
					7/12/95	7.81	14.4	237	132	111	41.1	3.99	34.2	6.31	28.8	27.5	0.26	N.A.	<0.002	0.002	0.016
					7/6/95	7.82	17.3	258	130	110	41	3.74	34	6.08	28.7	28.5	0.29	N.A.	<0.002	0.001	0.019
					6/29/95	7.80	16.4	236	131	118	42.3	4.04	36.8	6.35	28.7	28.4	0.22	N.A.	0.002	<0.001	0.017
M/O 384305-6	Infiltration Basin	QTar		160	9/7/96	7.77	N.A.	**1030**	87.8	502	149	1.23	143	35.30	**349**	117	**21.6**	N.A.	<0.003	<0.001	0.031
					8/14/96	7.77	N.A.	**898**	90	471	137	1.32	134	33.10	**326**	124	**19.5**	N.A.	<0.003	0.001	0.035
					8/2/96	7.75	N.A.	**965**	94.2	393	126	1.57	111	28.20	**310**	122	**21.6**	N.A.	0.004	0.001	0.028
					7/8/96	7.67	N.A.	**875**	98.7	401	138	0.88	115	27.7	**277**	120	**16.4**	N.A.	<0.003	0.002	0.027
					6/7/96	7.13	N.A.	**685**	109	326	121	1.51	92.3	23.2	225	119	**12.1**	N.A.	0.004	0.001	0.02
					11/18/95	7.05	12.4	**1820**	59.7	957	227	1.42	269	69.50	**721**	201	**37.20**	0.04	<0.003	0.001	0.031
					7/14/95	7.96	15.1	248	145	148	33	4.69	46.7	7.57	27.4	**31.4**	0.31	N.A.	<0.002	0.002	0.011
					7/6/95	7.88	17.4	263	143	139	33.7	4.53	43.7	7.27	26.8	**27.4**	0.32	N.A.	<0.002	0.001	0.012
					6/30/95	7.85	15.8	202	144	151	34	5.15	48.1	7.44	27.2	**27.9**	0.26	N.A.	<0.002	0.001	0.013
M/O 384305-6s	Infiltration Basin	QTar		40	9/7/96	7.67	N.A.	**1730**	75.4	820	200	1.73	232	58.5	**600**	157	**37.5**	N.A.	0.005	0.001	0.030
					8/15/96	7.62	N.A.	**1780**	74	887	209	1.54	251	63.3	**614**	172	**47.1**	N.A.	<0.003	<0.001	0.029
					8/2/96	7.71	N.A.	**1840**	77.4	714	180	2.09	200	52.3	**572**	181	**52.4**	N.A.	<0.003	0.001	0.020
					7/8/96	7.55	N.A.	**1830**	79.6	858	220	0.96	243	61.1	**612**	187	**45.2**	N.A.	<0.003	<0.001	0.028
					6/19/96	7.57	N.A.	**2290**	71.4	1023	229	1.71	286	75.0	**739**	222	**56.2**	N.A.	<0.003	0.002	0.028
M/O 384305-7	Infiltration Basin	QTar		140	7/10/96	7.74	N.A.	303	108	124	43.6	5.28	39.2	6.32	47.5	52.7	0.36	N.A.	<0.003	0.002	0.032
					11/19/95	7.32	13.1	256	106	94	34.2	4.99	30	4.73	21.4	32.4	0.38	0.02	<0.003	<0.001	0.023
					7/14/95	7.81	15.6	210	105	99	31.1	4.27	31.8	4.78	22.6	32.4	0.35	N.A.	<0.002	<0.001	0.025
					7/7/95	7.66	25.3	225	105	95	32.7	4.73	30.3	4.66	23	28.3	0.43	N.A.	<0.002	<0.001	0.028
					6/29/95	7.59	15.9	226	106	100	33	4.86	32.2	4.75	22.7	28	0.28	N.A.	<0.002	<0.001	0.036
M/O 384305-8	Infiltration Basin	QTar		140	7/10/96	7.56	N.A.	205	108	96	19.0	4.93	31.3	4.37	11.0	19.6	0.24	N.A.	<0.003	<0.002	0.031
					11/21/95	7.31	13.4	212	114	105	21.2	4.41	34.2	4.74	9.8	19.7	0.24	0.02	<0.003	<0.001	0.033
					7/17/95	7.81	16.4	202	115	113	19.5	4.76	37.2	4.87	10.7	25.3	0.25	N.A.	<0.002	<0.001	0.035
					7/9/95	7.84	15.7	215	112	113	20.3	4.80	37.3	4.88	10.4	27.4	0.20	N.A.	<0.002	0.001	0.038
					6/30/95	8.65	15.4	232	101	163	21.6	5.68	58.2	4.17	10.6	73.7	0.24	N.A.	<0.002	0.002	0.045
M/O 384305-9	Infiltration Basin	QTar		140	9/6/96	7.87	N.A.	163	85.4	80	26.1	4.22	25.6	4.01	16.4	20.0	0.28	N.A.	<0.003	0.004	0.038
					7/10/96	7.74	N.A.	232	89.6	97	30.2	3.08	30.4	5.22	24.3	45.8	0.31	N.A.	<0.003	0.003	0.046
					11/28/95	7.39	13.9	223	93.8	99	30.6	3.05	31.2	5.14	21.8	40.8	0.37	0.06	0.007	0.003	0.046
					7/17/95	8.06	21.4	222	87.3	103	26.5	3.00	34.9	3.84	20.9	45.2	0.36	N.A.	<0.002	0.003	0.034
					7/9/95	7.92	23.3	231	87.2	102	26.7	3.39	35.5	3.16	20.3	46.3	0.40	N.A.	<0.002	0.003	0.049
					7/3/95	7.89	20.9	235	85.4	119	28.7	4.13	43.6	2.48	20.5	61.2	0.35	N.A.	<0.002	0.004	0.027
M/O 384305-10	Infiltration Basin	QTar		160	11/20/95	7.44	12.8	219	105	95	33.8	4.42	30.8	4.45	20.7	26.9	0.33	0.02	<0.003	0.001	0.028
					7/15/95	7.69	18.0	212	109	96	31.3	4.89	31.1	4.49	21.6	30.6	0.35	N.A.	0.002	<0.001	0.037
					7/10/95	7.71	29.6	313	106	93	32.1	5.05	30	4.29	21.9	26.5	0.4	N.A.	<0.002	0.001	0.039
					7/4/95	7.97	21.3	231	106	92	32.2	5.34	29.7	4.3	22	27.2	0.4	N.A.	<0.002	<0.001	0.037
M/O 384305-11	Infiltration Basin	QTar		116	9/10/96	7.38	N.A.	230	95.2	50	45.3	3.49	14.2	3.57	11.0	15.7	0.24	N.A.	<0.003	0.047	0.021
					8/22/96	7.46	N.A.	221	87.6	63	37.2	3.77	17.2	4.91	11.4	16.0	0.29	N.A.	<0.003	0.026	0.02

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
M/O 384305-5 (Cont.)	Infiltration Basin	OTar		140	11/19/95	0.077	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.005	<0.017	<0.001	N.A.	<0.01	<0.002
					7/12/95	0.087	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.006	<0.021	<0.001	N.A.	<0.001	<0.002
					7/6/95	0.028	<0.002	<0.003	0.003	0.40	<0.017	<0.0002	0.008	<0.021	<0.001	N.A.	<0.001	<0.002
					6/29/95	0.086	<0.002	0.004	0.005	0.40	<0.017	<0.0002	0.01	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-6	Infiltration Basin	OTar		160	9/7/96	N.A.	<0.0024	<0.005	<0.003	0.8	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.002	<0.002
					8/14/96	N.A.	<0.0024	<0.005	<0.003	0.7	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.001	<0.002
					8/2/96	N.A.	<0.0024	<0.005	0.004	0.7	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.002	<0.002
					7/8/96	0.044	<0.0024	<0.005	<0.003	1.0	<0.024	<0.0002	<0.002	N.A.	0.002	<0.002	<0.002	<0.002
					6/7/96	0.097	<0.0024	<0.005	<0.003	1.0	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.005	<0.002
					11/18/95	0.087	<0.0024	<0.005	<0.003	1.10	<0.024	<0.0002	<0.001	<0.017	<0.001	N.A.	<0.001	<0.002
					7/14/95	0.084	<0.002	<0.003	0.004	0.30	<0.017	<0.0002	0.003	<0.021	<0.001	N.A.	<0.001	0.003
					7/6/95	0.024	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.003	<0.021	<0.001	N.A.	<0.001	<0.002
					6/30/95	0.088	<0.002	0.005	<0.003	0.30	<0.017	<0.0002	0.001	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-6s	Infiltration Basin	OTar		40	9/7/96	N.A.	<0.0024	<0.005	<0.003	0.5	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.001	<0.002
					8/15/96	N.A.	<0.0024	<0.005	<0.003	0.4	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.005	<0.002
					8/2/96	N.A.	<0.0024	<0.005	<0.003	0.7	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.002	<0.002
					7/8/96	0.045	<0.0024	<0.005	<0.003	0.8	<0.024	<0.0002	<0.002	N.A.	0.002	<0.002	<0.002	<0.002
					6/19/96	0.102	<0.0024	0.005	<0.003	0.9	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	0.002	<0.002
M/O 384305-7	Infiltration Basin	OTar		140	7/10/96	N.A.	<0.0024	<0.005	<0.003	0.3	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					11/19/95	0.088	<0.0024	<0.005	<0.003	0.30	<0.024	<0.0002	0.001	<0.017	<0.001	N.A.	<0.01	<0.002
					7/14/95	0.080	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.004	<0.021	<0.001	N.A.	<0.001	<0.002
					7/7/95	0.032	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.007	<0.021	<0.001	N.A.	<0.001	<0.002
					6/29/95	0.088	<0.002	<0.004	<0.003	0.30	<0.017	<0.0002	0.01	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-8	Infiltration Basin	OTar		140	7/10/96	N.A.	<0.0024	<0.005	<0.003	0.1	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					11/21/95	0.061	<0.0024	<0.005	<0.003	<0.1	<0.024	<0.0002	0.001	<0.017	<0.001	N.A.	<0.01	<0.002
					7/17/95	0.068	<0.002	<0.003	<0.003	0.10	<0.017	<0.0002	0.003	<0.021	<0.001	N.A.	<0.001	<0.002
					7/9/95	<0.014	<0.002	<0.003	<0.003	0.10	<0.017	<0.0002	0.003	<0.021	<0.001	N.A.	<0.001	<0.002
					6/30/95	0.065	<0.002	<0.003	<0.003	0.10	<0.017	<0.0002	<0.001	<0.021	<0.001	N.A.	<0.01	<0.002
M/O 384305-9	Infiltration Basin	OTar		140	9/6/96	N.A.	<0.0024	<0.005	<0.003	0.2	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.005	<0.002
					7/10/96	N.A.	<0.0024	<0.005	<0.003	0.2	<0.024	<0.0002	<0.002	N.A.	<0.001	<0.002	<0.002	<0.002
					11/28/95	0.090	<0.0024	<0.005	0.004	0.20	<0.024	<0.0002	0.005	<0.017	<0.001	N.A.	<0.01	<0.002
					7/17/95	0.083	<0.002	<0.003	0.005	0.30	<0.017	<0.0002	0.001	<0.021	<0.001	N.A.	<0.001	<0.002
					7/9/95	0.027	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.002	<0.021	<0.001	N.A.	<0.001	<0.002
					7/3/95	0.060	<0.002	<0.004	0.016	0.30	<0.017	<0.0002	<0.001	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-10	Infiltration Basin	OTar		160	11/20/95	0.093	<0.0024	<0.005	<0.003	0.30	<0.024	<0.0002	0.002	<0.017	0.002	N.A.	<0.01	<0.002
					7/15/95	0.094	<0.002	<0.003	0.019	0.40	0.019	<0.0002	0.046	<0.021	<0.001	N.A.	<0.001	<0.002
					7/10/95	0.031	<0.002	<0.003	<0.017	0.40	<0.017	<0.0002	0.033	<0.021	<0.001	N.A.	<0.001	<0.002
					7/4/95	0.073	<0.002	<0.004	<0.017	0.40	<0.017	<0.0002	0.036	<0.021	<0.001	N.A.	<0.001	<0.002
M/O 384305-11	Infiltration Basin	QTar		116	9/10/96	0.077	<0.0024	<0.005	<0.003	0.1	**0.757**	<0.0002	**0.056**	N.A.	<0.001	<0.002	<0.001	<0.002
					8/22/96	0.094	<0.0024	<0.005	<0.003	0.1	**0.586**	<0.0002	0.034	N.A.	<0.001	<0.002	<0.005	<0.002

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
M/O 384305-12	Infiltration Basin	QTar		140	9/10/96	7.57	N.A.	217	87.9	100	37.8	2.51	31.3	5.42	36.3	42.2	0.22	N.A.	<0.003	0.005	0.053
					8/7/96	7.57	N.A.	271	97.6	81	57.3	3.31	25.1	4.57	32.6	45.4	0.21	N.A.	<0.003	0.014	0.026
M/O 384305-13	Infiltration Basin	QTar		125	9/10/96	7.59	N.A.	168	89.9	68	33.2	3.66	20.9	3.85	15.7	22.6	0.33	N.A.	<0.003	0.012	0.023
					8/16/96	7.43	N.A.	278	98.1	86	52.3	4.28	25.5	5.48	18.4	48.5	0.31	N.A.	<0.003	0.015	0.032
M/Q 384305-14	Infiltration Basin	QTar		135	9/10/96	7.65	N.A.	205	85.2	74	38.7	2.55	22.6	4.35	29.2	30.2	0.24	N.A.	<0.003	0.010	0.038
					8/16/96	7.16	N.A.	332	87.5	42	72.1	3.11	11.0	3.42	24.5	30.3	0.18	N.A.	0.006	0.029	0.033
M/O 384315-1	~3 mi. W of Desmond Ranch	QTag	100	400	11/4/95	7.94	15.1	205	111	68	37.2	5.52	23.7	2.2	15.1	17.1	0.20	0.450	<0.003	<0.04	0.018
					8/9/95	7.86	17.4	196	112	69	35.5	5.38	23.8	2.31	15.6	17.5	0.200	0.700	<0.0022	<0.042	0.0171
					5/12/95	8.20	14.8	210	110	66	34.5	5.20	22.9	2.14	15.3	17.9	0.230	0.545	<0.002	<0.040	0.0173
					3/16/95	8.10	16.2	200	111	71	39.8	5.58	24.7	2.37	16.0	18.0	0.20	0.705	<0.002	<0.04	0.0180
					12/16/94	8.10	14.6	205	110	71	39.3	5.5	24.7	2.31	14.9	17.9	0.19	0.64	<0.002	<0.04	0.019
					9/9/94	**8.79**	18.3	256	113	64	40	5.4	22	2.2	16	20	0.30	1.7	<0.0005	0.023	<0.1
					6/12/94	**8.95**	21.4	229	108	57	48	6.4	20	1.8	16	24	0.30	<0.1	0.0006	0.036	<0.1
					3/24/94	**9.46**	15.2	255	132	46	57	4.8	16	1.5	23	30	0.30	<0.1	0.0009	**0.057**	<0.1
M/Q 384329-1	near Kelly Creek	QTar	100	80	10/8/95	7.42	12.6	260	100	120	30.7	4.79	36.8	6.7	15.9	57.4	0.45	0.050	<0.002	<0.04	0.056
					8/3/95	7.56	18.1	245	100	115	31	4.83	35.6	6.37	15.1	52.5	0.470	0.131	<0.002	<0.04	0.051
					5/10/95	7.66	14.3	219	99.9	98	27.1	4.51	30.4	5.28	15.1	44.2	0.560	<0.082	<0.002	<0.040	0.0455
					3/17/95	7.60	13.4	212	100	101	30.3	4.09	31	5.71	15.0	41.3	0.52	0.062	<0.002	<0.04	0.051
					11/16/94	7.50	10.6	211	99	88	27.6	4.2	27.5	4.8	12.6	29.8	0.52	<0.3	<0.004	<0.04	0.042
					9/6/94	8.14	18.7	216	102	87	26	3.8	27	4.7	12	26	0.60	<0.1	<0.0005	0.012	<0.1
					6/13/94	7.76	16.1	206	94	85	26	3.8	27	4.3	12	23	0.50	<0.1	<0.0005	0.013	<0.1
					3/25/94	**8.88**	13.9	184	99	101	20	3.5	35	3.3	15	24	0.30	<0.1	0.0005	0.015	<0.1
M/O 384331-1	near Summer Camp Creek	QTar	100	78	10/8/95	7.45	14.6	**821**	136	510	55.7	5.15	158	28.0	**277**	96.9	0.69	0.030	<0.002	<0.04	0.151
					8/3/95	7.44	18.8	**841**	136	514	56.3	5.35	160	27.9	**321**	102	0.72	0.144	<0.002	<0.04	0.132
					5/10/95	7.28	14.2	**766**	120	443	50.5	4.74	138	23.8	**274**	102	0.700	<0.082	<0.002	<0.040	0.130
					3/28/95	7.50	10.7	**675**	136	522	56.7	5.32	164	27.2	**255**	85.9	0.69	<0.082	<0.005	<0.04	0.143
					11/16/94	7.40	10.3	**769**	16	451	53.3	4.8	140	24.6	**259**	81.7	0.70	<0.3	<0.004	<0.04	0.134
					9/9/94	7.66	14.4	**894**	134	491	52	4.9	152	27.0	**260**	83	0.70	<0.1	<0.0005	0.007	0.2
					6/13/94	7.30	N.A.	**890**	130	483	57	5.9	152	25.0	**260**	81	0.70	<0.1	0.0011	0.006	0.2
					3/26/94	7.73	13.1	**828**	136	526	36	3.8	171	24.0	**268**	89	0.70	<0.1	0.0011	0.007	0.2
M/Q 384331-2	near Summer Camp Creek	QTar	100	78	10/8/95	7.83	14.8	410	121	245	42.7	4.65	76.3	13.3	74.0	98.1	0.16	0.020	<0.002	<0.04	0.129
					8/3/95	7.97	18.2	255	115	131	32.5	4.07	40.9	7.01	29.1	37.8	0.170	0.087	<0.002	<0.04	0.066
					5/10/95	8.07	14.9	226	117	104	28.2	3.41	32.5	5.49	25.0	27.9	0.170	<0.082	<0.002	<0.040	0.0599
					3/28/95	7.90	11.1	204	116	128	33.1	3.65	40.3	6.69	29.1	34.3	0.17	<0.082	<0.005	0.047	0.0728
					11/16/94	7.70	11.6	439	122	229	45.2	4.4	71.4	12.2	75	84.3	0.13	<0.3	<0.004	<0.04	0.109
					9/6/94	8.09	18.2	409	120	222	42	4.4	69	12.0	80	77	0.20	<0.1	<0.0005	0.023	0.1
					6/13/94	7.85	18.4	224	110	93	29	3.8	29	5.0	16	20	0.20	<0.1	<0.0005	0.028	<0.1
					3/26/94	8.13	10.7	204	110	103	25	3.1	33	5.0	19	19	0.20	<0.1	0.0005	0.027	<0.1

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
M/O 384305-12	Infiltration Basin	OTar		140	9/10/96	0.100	<0.0024	<0.005	<0.003	0.1	<0.024	<0.0002	<0.002	N.A.	0.002	<0.002	0.002	<0.002
					8/7/96	0.110	<0.0024	0.006	<0.003	0.2	0.077	<0.0002	0.005	N.A.	<0.001	<0.002	<0.005	<0.002
M/O 384305-13	Infiltration Basin	OTar		125	9/10/96	0.078	<0.0024	<0.005	<0.003	0.2	0.082	<0.0002	0.004	N.A.	<0.001	<0.002	0.001	<0.002
					8/16/96	0.104	0.0029	<0.005	<0.003	0.2	0.170	<0.0002	0.012	N.A.	<0.001	<0.002	<0.005	0.010
M/O 384305-14	Infiltration Basin	OTar		135	9/10/96	0.100	<0.0024	<0.005	<0.003	0.2	0.077	<0.0002	0.006	N.A.	<0.001	<0.002	<0.001	<0.002
					8/16/96	0.127	<0.0024	0.008	0.004	0.2	**1.29**	<0.0002	**0.097**	N.A.	<0.001	<0.002	<0.005	0.015
M/O 384315-1	~3 mi. W of Desmond Ranch	OTag	100	400	11/4/95	0.051	<0.0024	<0.005	<0.003	0.50	<0.024	<0.002	<0.001	<0.017	<0.001	<0.001	<0.04	<0.002
					8/9/95	0.096	<0.0019	<0.002	0.0017	0.5	<0.0011	<0.0002	<0.0009	<0.0069	<0.001	<0.001	**<0.061**	<0.0019
					5/12/95	0.127	<0.002	<0.003	<0.003	0.60	0.023	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	<0.001	0.0024
					3/16/95	0.104	<0.002	<0.004	<0.002	0.70	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**0.027**	<0.001	<0.004
					12/16/94	0.12	<0.002	<0.004	<0.002	0.50	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.02**	<0.001	<0.004
					9/9/94	0.10	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/12/94	0.10	0.0004	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/24/94	0.10	<0.0002	<0.05	<0.1	0.80	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384329-1	near Kelly Creek	OTar	100	80	10/8/95	0.097	<0.002	<0.003	<0.003	0.30	<0.017	<0.002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					8/3/95	0.059	<0.002	<0.003	0.011	0.3	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	0.003
					5/10/95	0.102	<0.002	<0.003	<0.003	0.42	<0.017	<0.0002	0.0019	<0.021	**<0.04**	**<0.018**	<0.001	0.0023
					3/17/95	0.083	<0.002	<0.004	<0.002	0.40	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.001	<0.004
					11/16/94	<0.01	<0.004	<0.004	<0.003	0.33	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/6/94	0.10	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	<0.1	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/13/94	<0.1	0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/25/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384331-1	near Summer Camp Creek	OTar	100	78	10/8/95	0.124	<0.002	0.005	0.011	0.20	<0.017	<0.002	<0.001	<0.021	<0.001	<0.001	<0.041	0.002
					8/3/95	0.073	<0.002	<0.003	0.006	<0.01	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					5/10/95	0.118	<0.0020	0.0041	<0.003	<0.1	0.033	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	0.002	<0.002
					3/28/95	0.098	<0.005	<0.003	<0.010	0.11	<0.050	<0.0002	<0.001	<0.02	**<0.04**	**<0.018**	0.002	<0.005
					11/16/94	0.01	<0.004	0.005	<0.003	<0.1	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	0.001	<0.004
					9/9/94	0.10	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	<0.1	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/13/94	0.10	0.0011	<0.05	<0.1	0.20	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/26/94	0.10	<0.0002	<0.05	<0.1	0.10	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384331-2	near Summer Camp Creek	OTar	100	78	10/8/95	0.119	<0.002	0.006	<0.003	0.30	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					8/3/95	0.072	<0.002	<0.003	0.006	0.3	<0.017	<0.0002	<0.001	<0.021	**0.019**	<0.001	<0.041	<0.002
					5/10/95	0.116	<0.0020	0.0051	<0.003	0.40	<0.017	<0.0002	0.001	<0.021	**<0.04**	**<0.018**	<0.001	0.0027
					3/28/95	0.113	<0.005	<0.003	<0.010	0.42	<0.050	<0.0002	<0.001	<0.02	**<0.04**	**<0.018**	<0.001	<0.005
					11/16/94	0.04	<0.004	<0.004	<0.003	0.30	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/6/94	0.10	<0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/13/94	0.10	0.0003	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/26/94	<0.1	<0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.1	<0.0010	**<0.5**	<0.001	<0.1

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
M/O 394224-1	west of pit	Pu	200	800	10/4/95	7.80	16.7	260	190	185	40.4	2.5	37.2	22.4	18.4	39.5	0.63	0.106	<0.002	<0.04	0.056
					8/1/95	7.94	19.8	226	190	169	38.5	2.26	33.9	20.5	17.8	43.7	0.66	0.116	<0.002	<0.04	0.047
					6/13/95	7.90	18.7	267	190	187	41.7	2.99	38.4	22.2	18.7	39.6	0.64	0.184	<0.002	<0.04	0.060
					3/5/95	7.90	12.2	231	189	183	40.8	2.6	37.5	21.8	19.0	39.3	0.70	0.329	<0.002	<0.04	0.050
					12/7/94	8.10	14.6	278	191	184	42.2	2.9	38	21.8	18.1	40.7	0.58	0.46	<0.002	**0.060**	0.049
					9/24/94'	7.91	18.7	284	187	179	39	2.8	37	21.0	18	39	0.60	1.4	<0.0005	**0.093**	<0.1
					7/15/94	7.78	20.2	304	186	175	46	3.9	37	20.2	21	40	0.70	<0.1	<0.0005	**0.130**	<0.1
M/O 394304-1	NE of north mill area	Pu	100	600	10/7/95	7.76	17.3	308	135	139	36.5	6.65	46.8	5.3	20.8	34.9	3.00	0.109	<0.002	<0.04	0.069
					8/4/95	7.82	19.9	303	135	140	38	7.5	47.6	5.22	20.7	35.0	2.98	0.308	<0.002	<0.04	0.0640
					6/23/95	7.85	19.2	312	135	146	38.2	7.01	50	5.15	22.2	36.0	3.04	0.289	<0.002	<0.04	0.0710
					3/6/95	7.80	15.3	275	140	142	40.7	6.79	48.2	5.27	25.0	35.0	3.00	0.348	<0.002	<0.04	0.0720
					12/20/94	7.40	11.3	432	146	209	58.8	8.0	71.2	7.44	41.6	34.9	2.76	0.94	<0.002	<0.04	0.107
					10/24/94	6.90	21.1	**735**	148	222	74	7.0	77	7.3	79	29	1.60	1.5	<0.0005	0.016	0.1
M/O 394318-1	W of Main Ent Rd., W of pit	Pu	300	1000	11/1/95	7.49	15.7	339	188	230	31.2	3.5	55.6	22.3	14.8	75.0	<0.02	<0.082	0.006	**0.65**	0.048
					8/18/95'	7.65	20.1	283	190	224	32.6	3.74	54.2	21.5	15.7	66.7	<0.02	<0.082	<0.002	**0.47**	0.051
					6/14/95'	7.55	17.9	305	189	227	31	3.74	55.2	21.7	15.3	68.3	<0.02	<0.082	<0.002	**0.51**	0.050
					3/31/95'	7.60	19.2	248	185	240	31.4	4.04	59.6	22.3	14.6	72.1	<0.02	<0.082	<0.005	**0.67**	0.0486
					12/21/94'	7.40	14.7	319	188	268	33.4	4.0	64.8	25.9	13.8	93.8	<0.02	<0.06	<0.002	**0.750**	0.045
					9/17/94'	7.16	19.4	423	155	269	31	4.5	65	26.0	13	140	0.10	<0.1	<0.0005	**0.950**	<0.1
M/O 394319-2	near pit, west	Pu	200 & 100	500	11/8/95	7.76	16.9	285	198	187	36.0	3.52	40.3	21.0	14.3	46.0	0.23	<0.078	0.005	**0.20**	0.048
					8/17/95	7.78	18.0	265	199	195	38.1	3.59	42.1	22	13.9	47.7	0.23	<0.082	<0.002	**0.21**	0.053
					6/5/95	7.78	16.1	252	198	197	37.1	3.36	42.5	22.1	14.1	46.2	0.23	<0.082	<0.002	**0.22**	0.0524
					3/28/95	7.80	13.6	184	193	205	36.8	3.54	45.5	22.3	12.8	47.8	0.23	<0.082	<0.005	**0.22**	0.0546
					11/20/94	7.70	16.6	257	199	193	37.3	3.3	41.8	21.6	13	46.1	0.22	<0.3	<0.004	**0.170**	0.052
					9/20/94'	7.82	17.5	284	195.7	193	35.2	3.29	41.6	21.6	13.7	47.2	N.A.	<0.057	<0.002	**0.2**	0.0515
					9/16/94	7.99	18.8	290	190	193	36	3.5	41	22.0	13	47	0.30	<0.1	<0.0005	**0.250**	<0.1
					6/5/94	7.73	20.6	293	189	177	34	3.9	38	20.0	13	47	0.24	<0.1	<0.0005	**0.170**	<0.1
					3/29/94	8.04	17.6	320	189	187	33	3.5	42	20.0	16	49	0.20	<0.1	0.0006	**0.190**	<0.1
M/O 394319-5	near pit, south	QTal	100	464	11/20/94	7.80	13.6	230	131	167	24.7	3.3	38.5	17.2	26.9	45.5	1.22	<0.3	<0.004	<0.04	0.045
					9/21/94'	7.91	27.8	250	123.6	178	24.7	3.69	41.2	18.2	29.1	46.8	1.12	0.061	<0.002	0.020	0.0489
					9/16/94	8.00	16.6	259	127	169	24	3.3	38	18.0	27	47	1.20	<0.1	<0.0005	0.020	<0.1
					6/5/94	7.91	15.6	268	125	158	25	3.6	37	16.0	29	45	1.40	<0.1	<0.0005	0.021	<0.1
					3/31/94	8.08	13.6	234	126	168	21	2.8	41	16.0	31	46	1.50	<0.1	0.0005	0.021	<0.1
M/O 394319-12	near pit, east	Pu	500?	850	10/24/95	7.68	18.6	275	175	231	23.0	3.32	51.7	24.8	26.3	61.8	<0.02	<0.082	<0.002	<0.04	0.042
					8/10/95	7.77	20.7	288	175	235	22.3	3.18	52	25.7	25.8	62.6	<0.02	0.200	<0.0022	<0.042	0.0393
					6/5/95	7.76	16.3	277	175	240	23.4	3.57	53.2	26	28.0	60.6	<0.02	<0.082	<0.002	**0.05**	0.0423
					3/14/95	7.90	17.8	260	175	237	23.5	3.35	51.8	26.1	27.0	62.0	<0.02	<0.057	<0.002	**0.05**	0.0450
					12/2/94	7.60	17.6	279	172	247	24	3.7	54.7	26.8	26.5	61.6	<0.02	<0.3	<0.004	**0.05**	0.045
					9/14/94	7.79	19.3	311	169	230	22	3.4	51	25.0	25	63	<0.1	<0.1	<0.0005	0.049	<0.1
					6/7/94	7.75	17.2	299	167	214	22	3.9	48	23.0	25	62	<0.1	<0.1	<0.0005	**0.061**	<0.1

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
M/O 394224-1	west of pit	Pu	200	800	10/4/95	0.161	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					8/1/95	0.138	<0.002	<0.003	<0.003	0.4	<0.017	<0.0002	<0.001	<0.021	0.001	<0.001	<0.041	<0.002
					6/13/95	0.145	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	<0.001	0.005
					3/5/95	0.154	<0.002	<0.004	0.002	0.40	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.001	<0.004
					12/7/94	0.17	<0.002	<0.004	<0.002	0.40	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.02**	<0.001	<0.004
					9/24/94	0.20	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.01	<0.0020	**<0.5**	<0.001	<0.1
					7/15/94	0.14	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.1	<0.0020	**<0.5**	<0.001	<0.1
M/O 394304-1	NE of north mill area	Pu	100	600	10/7/95	0.175	<0.002	0.004	<0.003	0.40	<0.017	<0.0002	0.002	<0.021	<0.001	<0.001	<0.041	0.003
					8/4/95	0.131	<0.002	<0.003	<0.003	0.4	<0.017	<0.0002	0.002	<0.021	<0.001	<0.001	<0.041	0.007
					6/23/95	0.128	<0.002	0.014	0.003	0.40	<0.017	<0.0002	0.002	<0.021	**<0.04**	**<0.018**	<0.01	<0.002
					3/6/95	0.177	<0.002	<0.004	<0.002	0.50	<0.006	<0.0002	0.002	<0.01	**<0.04**	**<0.024**	<0.001	<0.004
					12/20/94	0.26	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	0.022	<0.01	**<0.04**	**<0.02**	<0.001	0.009
					10/24/94	0.31	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	**0.1**	<0.1	<0.0020	**<0.5**	<0.001	<0.1
M/O 394318-1	W of Main Ent Rd., W of pit	Pu	300	1000	11/1/95	0.141	<0.002	<0.003	<0.003	0.50	**3.19**	<0.0002	**0.103**	<0.021	<0.001	**1.4**	<0.041	<0.002
					8/18/95	N.A.	<0.002	<0.003	<0.003	0.5	**2.46**	<0.0002	**0.100**	<0.021	<0.001	**1.37**	<0.041	0.005
					6/14/95	N.A.	<0.002	<0.003	<0.003	0.50	**2.74**	<0.0002	**0.102**	<0.021	**<0.04**	**0.84**	<0.001	<0.002
					3/31/95	N.A.	<0.005	<0.003	<0.010	0.60	**2.96**	<0.0002	**0.111**	<0.02	**<0.04**	**1.12**	<0.001	<0.005
					12/21/94	0.18	<0.002	<0.004	<0.002	0.60	**3.63**	<0.0002	**0.14**	<0.01	**<0.04**	**0.54**	<0.001	0.008
					9/17/94	0.20	<0.0002	<0.05	<0.1	0.30	**2.8**	<0.0005	**<0.2**	<0.1	<0.0020	**1.40**	<0.001	<0.1
M/O 394319-2	near pit, west	Pu	200 & 100	500	11/8/95	0.160	<0.0024	<0.005	<0.003	0.60	<0.024	<0.0002	<0.001	<0.017	<0.001	0.001	<0.04	<0.002
					8/17/95	0.167	<0.002	<0.003	<0.003	0.5	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	0.01
					6/5/95	0.156	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	<0.001	<0.002
					3/28/95	0.163	<0.005	<0.003	<0.010	0.57	<0.050	<0.0002	<0.001	<0.020	**<0.04**	**<0.018**	<0.001	<0.005
					11/20/94	0.06	<0.004	<0.004	<0.003	0.51	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/20/94	N.A.	<0.002	<0.004	<0.002	0.54	<0.006	<0.0002	<0.002	<0.01	<0.001	**0.027**	<0.001	<0.004
					9/16/94	0.2	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	**<0.1**	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/5/94	0.2	<0.0002	<0.05	<0.1	0.55	<0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/29/94	0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1
M/O 394319-5	near pit, south	QTal	100	464	11/20/94	<0.01	<0.004	<0.004	<0.003	0.47	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/21/94	N.A.	<0.002	<0.004	<0.002	0.48	<0.006	<0.0002	<0.002	<0.01	<0.001	**<0.024**	<0.001	<0.004
					9/16/94	0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	**<0.1**	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/5/94	0.1	<0.0002	<0.05	<0.1	0.47	<0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/31/94	<0.1	<0.0002	<0.05	<0.1	0.40	0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1
M/O 394319-12	near pit, east	Pu	500?	850	10/24/95	0.112	<0.002	<0.003	<0.003	0.40	0.024	<0.0002	0.023	<0.021	0.001	**0.003**	<0.041	0.003
					8/10/95	0.137	<0.0019	<0.002	<0.0017	0.4	0.0212	<0.0002	0.0234	<0.0069	<0.001	0.004	<0.061	0.0031
					6/5/95	0.112	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.0268	<0.021	**<0.04**	**<0.018**	<0.001	0.0026
					3/14/95	0.120	<0.002	<0.004	<0.002	0.40	0.012	<0.0002	0.024	<0.01	**<0.04**	**<0.024**	<0.001	<0.004
					12/2/94	0.13	<0.004	<0.004	<0.003	0.36	<0.009	<0.0002	0.026	<0.02	**<0.04**	**0.027**	<0.001	<0.004
					9/14/94	0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/7/94	0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)	Ba (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05	2
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1		
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500					
M/O 394321-1	east of waste dumps	QTar	100	513	11/5/95	7.91	12.8	182	108	67	35.9	5.16	22.6	2.5	13.9	15.9	0.15	0.109	<0.003	<0.04	0.006
					8/13/95	7.67	14.6	189	110	69	35.5	4.97	22.9	2.77	14.4	16.8	0.16	<0.1	<0.0022	<0.042	0.0046
					6/1/95	7.67	13.3	204	108	71	37	5.52	23.8	2.74	14.6	16.3	0.18	0.082	<0.002	<0.04	0.0083
					2/27/95	7.90	13.4	204	109	66	34.4	5.73	22.4	2.53	12.8	15.2	0.11	0.233	<0.002	<0.04	0.006
					11/30/94	7.70	12.4	182	108	72	38.3	5.6	24.2	2.92	13.6	16.1	0.13	<0.3	<0.004	<0.04	0.007
					9/26/94'	8.10	19.2	200	108	73	33	5.1	21	5.1	13	16	0.10	<0.1	<0.0005	0.009	<0.1
					6/9/94	7.88	15.0	203	102	60	35	5.8	20	2.4	13	16	0.12	<0.1	<0.0005	0.006	<0.1
					3/28/94	8.00	17.2	218	108	64	32	5.4	21	2.8	15	18	0.10	<0.1	0.0009	0.007	<0.1
M/O 394329-1	east of tailings E	OTar	100	124	9/22/94'	7.37	15.8	436	133.9	237	41.1	3.88	68.3	16.1	110	38.8	N.A.	0.05	<0.002	0.003	0.0727
M/O 394329-2	south of tailings E	OTar	100	105	10/12/94'	7.21	12.9	302	120	74	62.8	4.25	20.1	5.81	28	23.6	0.87	3.45	<0.002	0.025	0.0065
M/O 394329-3	west of tailings E	OTar	100	64	10/12/94'	7.60	11.1	224	165	149	30.4	3.08	41.4	11.1	36.4	12.4	0.45	0.077	<0.002	0.009	0.0806
M/O 394330 D-1	south of pit	Pu		805	10/19/95	7.75	17.8	196	157	158	25.3	3.17	34.4	17.6	14.9	31.8	0.50	<0.082	<0.002	**0.18**	0.068
					8/19/95	8.18	20.1	225	154	162	26.5	2.75	34.8	18.3	15.3	33.7	0.550	<0.082	<0.002	**0.21**	0.0720
					5/18/95	7.94	19.1	200	153	159	25.5	3.01	34.9	17.6	14.6	30.9	0.580	<0.082	<0.002	**0.112**	0.0700
					3/29/95	7.93	19.1	165	149	166	25.7	3.28	36.4	18.3	15.0	31.7	N.A.	<0.082	<0.005	**0.19**	0.0707
					11/19/94	7.80	15.6	202	154	155	25.3	3.6	33.7	17.3	14.8	30	0.53	<0.3	<0.004	**0.190**	0.067
					9/12/94	8.00	17.3	219	148	156	24	3.3	33	18.0	15	30	0.60	<0.1	<0.0005	**0.170**	<0.1
					6/4/94	7.96	18.4	230	146	146	24	3.5	32	16.0	15	30	0.53	<0.1	<0.0005	**0.140**	<0.1
					3/30/94	8.05	18.7	218	150	156	21	2.9	36	16.0	17	30	0.50	<0.1	0.0005	**0.200**	<0.1
M/O 394330 S-1	south of pit	OTal	100	500	11/1/95	7.89	14.2	211	135	133	27.2	3.37	31.1	13.4	14.4	21.9	0.46	<0.082	<0.002	<0.04	0.087
					8/17/95	7.91	17.1	193	134	125	26.2	2.8	29.5	12.6	14.3	22.4	0.47	<0.082	<0.002	<0.04	0.081
					6/2/95	7.73	16.2	186	137	133	25.8	2.91	32.2	12.9	13.9	21.0	0.51	<0.082	<0.002	<0.04	0.084
					3/4/95	8.00	12.2	149	135	125	25.6	2.73	29.3	12.5	14.0	22.0	0.48	<0.057	<0.002	<0.04	0.080
					11/21/94	7.90	13.9	182	135	125	26	3.2	29.6	12.4	13.7	21.6	0.46	<0.3	<0.004	<0.04	0.084
					9/18/94'	8.00	17.4	201	130	126	25	2.8	29	13.0	14	21	0.60	<0.1	<0.0005	0.023	<0.1
					6/6/94	7.95	14.9	217	129	119	25	3.2	28	12.0	14	22	0.47	<0.1	<0.0005	0.016	<0.1
					3/26/94	8.03	13.6	192	134	138	23	2.8	34	13.0	16	20	0.50	<0.1	0.0006	0.015	<0.1
M/O 394331-1	E of Leach Pad G	QTal	100	130	9/22/94'	8.00	14.9	175	115.6	112	23.3	2.72	25.4	11.9	16.3	17.6	N.A.	0.03	<0.002	**0.059**	0.0688
M/O 394331-2	S of Leach Pad G	QTal	100	124	10/12/94'	7.96	13.1	164	120	112	24.2	3.17	26.4	11.2	18.2	16.1	0.62	<0.02	<0.002	**0.051**	0.0799
M/O 404215-1	NW of Dry Hills	Qae	100	402	10/20/95	8.25	16.5	255	130	82	54.5	7.72	23.4	5.7	22.2	30.4	<0.02	2.650	<0.002	<0.04	0.014
					8/2/95	**8.53**	18.6	233	131	76	51.5	7.49	21.8	5.33	22.3	32.7	0.96	2.83	<0.002	<0.04	0.011
					5/9/95	**8.53**	17.1	268	132	76	51.5	7.51	21.9	5.16	23.0	31.0	1.04	3.53	<0.002	<0.040	0.0119
					3/1/95	**8.50**	15.0	267	135	82	60.8	8.54	23.5	5.74	22.0	31.7	0.93	4.54	<0.002	<0.04	0.010
					12/20/94	**8.60**	11.3	283	137	78	66.4	7.7	22.2	5.46	22.5	33.3	0.87	6.75	<0.002	<0.04	0.01
					10/20/94	8.41	15.9	315	137	61	62	6.4	17	4.6	21	34	0.90	1.6	<0.0005	0.021	<0.1
M/O 404215-2	NW of Dry Hills	Qae	100	271.5?	10/20/95	7.81	16.1	235	123	80	48.1	7.11	22.4	5.9	23.2	30.0	0.89	0.259	<0.002	<0.04	0.034
					8/2/95	8.03	17.8	199	122	78	46.3	6.91	21.5	5.82	23.6	32.7	0.92	0.315	<0.002	<0.04	0.031
					5/9/95	8.03	15.1	244	122	78	45.4	7.35	21.8	5.73	24.3	30.0	1.06	0.444	<0.002	<0.040	0.033
					3/1/95	7.90	14.0	251	123	83	50.5	7.84	22.9	6.30	23.0	30.0	0.96	0.62	<0.002	<0.04	0.035
					12/9/94	8.00	12.9	247	123	85	49.3	7.5	23.5	6.49	24.2	30.2	0.95	0.96	0.003	<0.04	0.04
					10/20/94	7.89	14.7	273	121	73	42	6.4	20	5.5	22	30	0.80	1.6	<0.0005	0.016	<0.1

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Cr (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL							0.005	0.1	1.3	4		0.002		0.1	0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05					5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1					
M/O 394321-1	east of waste dumps	OTar	100	513	11/5/95	0.027	<0.0024	<0.005	<0.003	0.40	<0.0011	<0.0002	<0.001	<0.017	<0.001	<0.001	<0.04	<0.002
					8/13/95	0.063	<0.0019	<0.002	<0.0017	0.4	<0.0011	<0.0002	<0.0009	<0.0069	<0.001	<0.001	**<0.061**	0.0043
					6/1/95	0.063	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	<0.001	<0.002
					2/27/95	0.049	<0.002	<0.004	<0.002	0.40	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.010	<0.004
					11/30/94	0.08	<0.004	<0.004	<0.003	0.42	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/26/94[1]	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	**<0.1**	<0.01	<0.002	**<0.5**	<0.001	<0.1
					6/9/94	<0.1	<0.0002	<0.05	<0.1	0.77	<0.1	<0.0005	**<0.1**	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/28/94	<0.1	<0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	**<0.1**	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 394329-1	east of tailings E	OTar	100	124	9/22/94[1]	N.A.	<0.002	<0.004	<0.002	0.29	<0.006	<0.0002	**0.906**	<0.01	<0.001	**<0.024**	<0.001	0.0109
M/O 394329-2	south of tailings E	OTar	100	105	10/12/94[1]	N.A.	<0.002	<0.004	0.0048	0.579	0.0793	<0.0002	0.0033	<0.01	0.002	**<0.024**	<0.01	<0.004
M/O 394329-3	west of tailings E	OTar	100	64	10/12/94[1]	N.A.	<0.002	<0.004	0.007	0.394	0.165	<0.0002	**1.79**	0.011	0.001	**<0.024**	<0.001	0.0414
M/O 394330 D-1	south of pit	Pu		805	10/19/95	0.121	<0.002	<0.003	<0.003	0.60	0.166	<0.0002	0.017	<0.021	0.002	**0.003**	<0.041	<0.002
					8/19/95	0.116	<0.002	<0.003	<0.003	0.6	0.172	<0.0002	0.018	<0.021	<0.001	**0.008**	<0.041	<0.002
					5/18/95	0.113	<0.0020	<0.003	0.0075	0.60	0.163	<0.0002	0.0266	<0.021	**<0.04**	**<0.018**	<0.001	<0.002
					3/29/95	0.119	<0.005	<0.003	<0.010	0.65	0.134	<0.0002	0.0247	<0.02	**<0.04**	**<0.018**	<0.001	<0.005
					11/19/94	0.03	<0.004	<0.004	<0.003	0.62	0.098	<0.0002	0.019	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/12/94	0.1	<0.0002	<0.05	<0.1	0.70	0.1	0.0008	**<0.1**	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/4/94	0.1	<0.0002	<0.05	<0.1	0.63	0.2	<0.0005	**<0.1**	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/30/94	0.1	<0.0002	<0.05	<0.1	0.50	0.2	<0.0005	**<0.1**	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 394330 S-1	south of pit	OTal	100	500	11/1/95	0.122	<0.002	0.003	<0.003	0.50	<0.017	<0.0002	<0.001	<0.021	<0.001	**0.006**	<0.041	<0.002
					8/17/95	0.100	<0.002	<0.003	<0.003	0.5	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					6/2/95	0.105	<0.002	0.004	<0.003	0.50	<0.017	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	<0.001	0.067
					3/4/95	0.114	<0.002	<0.004	<0.002	0.50	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.001	<0.004
					11/21/94	<0.01	<0.004	<0.004	<0.003	0.53	<0.009	<0.0002	<0.002	<0.02	**<0.04**	**<0.02**	<0.001	<0.004
					9/18/94[1]	0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	**<0.1**	<0.01	<0.0020	**<0.5**	<0.001	<0.1
					6/6/94	0.1	<0.0002	<0.05	<0.1	0.53	<0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/26/94	0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.1	<0.001	**<0.5**	<0.001	<0.1
M/O 394331-1	E of Leach Pad G	QTal	100	130	9/22/94[1]	N.A.	<0.002	<0.004	<0.002	0.48	<0.006	<0.0002	<0.002	<0.01	<0.001	**<0.024**	<0.001	<0.004
M/O 394331-2	S of Leach Pad G	OTal	100	124	10/12/94[1]	N.A.	<0.002	0.0045	0.0053	0.591	<0.006	<0.0002	<0.002	0.01	<0.001	**<0.024**	<0.001	<0.004
M/O 404215-1	NW of Dry Hills	Qae	100	402	10/20/95	0.186	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	<0.001	<0.021	0.001	<0.001	<0.041	<0.002
					8/2/95	0.186	<0.002	<0.003	<0.003	0.6	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					5/9/95	0.214	<0.002	<0.003	<0.003	0.66	<0.017	<0.0002	<0.001	<0.021	**<0.04**	**<0.018**	<0.001	0.0029
					3/1/95	0.200	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.010	<0.004
					12/20/94	0.24	<0.002	<0.004	<0.002	0.70	0.026	<0.0002	<0.002	<0.01	**<0.04**	**<0.02**	<0.001	<0.004
					10/20/94	0.20	<0.0002	<0.05	<0.1	0.60	<0.1	0.0009	**<0.1**	<0.1	<0.002	**<0.1**	<0.001	<0.1
M/O 404215-2	NW of Dry Hills	Qae	100	271.5?	10/20/95	0.186	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	<0.001	<0.021	0.001	<0.001	<0.041	<0.002
					8/2/95	0.179	<0.002	<0.003	<0.003	0.7	<0.017	<0.0002	<0.001	<0.021	<0.001	<0.001	<0.041	<0.002
					5/9/95	0.206	<0.002	0.0034	<0.003	0.61	<0.017	<0.0002	0.001	<0.021	**<0.04**	**<0.018**	<0.001	0.0022
					3/1/95	0.200	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	<0.002	<0.01	**<0.04**	**<0.024**	<0.010	<0.004
					12/9/94	0.21	0.004	<0.004	<0.002	0.60	0.03	<0.0002	<0.002	<0.01	**<0.04**	**<0.02**	<0.01	0.008
					10/20/94	0.19	<0.0002	<0.05	<0.1	0.60	<0.1	0.0007	**<0.1**	<0.1	<0.002	**<0.1**	<0.001	<0.1

[1] = PTI sampled

Values in bold exceed applicable maximum contaminant levels.

N.A. = not analyzed

Sources: WESTEC 1995a, 1995c; and PTI 1996.

TBA-2FIN XLS

TABLE A-3
Treated Mine Water Discharge to Rabbit Creek

Determination	Rabbit Creek NPDES Discharge Limits		Sampled Discharge Range
	30-Day Average	Daily Maximum	
pH	6.5 to 9.0		7.5 to 8.26
TDS	500		267 to 1,040[1]
TSS	20 mg/l		<0.1 to 155[1]
Turbidity	20 NTU	50 NTU	0.01 to 54.8[1]
Cyanide-WAD		0.005 mg/l	<0.005
Phosphorus-Total		0.1 mg/l	<0.01 to 0.02
Arsenic		0.05 mg/l	0.007 to 0.110
Copper	0.15 mg/l	0.3 mg/l	<0.0017 to 0.010
Fe - Soluble	0.3 mg/l	0.6 mg/l	<0.008 to 0.331[1]
Lead		0.05 mg/l	<0.001 to 0.005
Zinc	75 mg/l	1.5 mg/l	<0.0019 to 0.0353
Total Petroleum HC-IR		1.0 mg/l	<1.0

[1]indicates value above permit limits

TABLE A-4
Water Quality Data for Water Discharged to the Reinfiltration Basins

Constituent	Units	Nevada Drinking Water Standards MCL		9/12/96[4]	6/10/96[5]	Average	Evaporation Loss[6]	
		Primary	Secondary				5%	7%
Physical Properties								
Dissolved Oxygen	mg/las O_2							
Color	color units		15[1]					
Alkalinity	mg/l as $CaCO_3$			166	111	139	146	149
TDS	mg/l@180°C		500[1]; 1000[2]	265	284	275	289	295
TSS	mg/l							
Turbidity	NTU	0.5						
Inorganic Nonmetal								
Chloride	mg/l as Cl		250[1]; 400[2]	19.0	18.3	19.0	20.0	20.4
Cyanide	mg/l as HCN	0.2			0.003	0.003	0.003	0.003
Fluoride	mg/l as F	0.5	2.0[3]	0.8	0.8	0.8	0.8	0.9
Nitrate	mg/l as N	10						
Nitrite	mg/l as N	1.0						
pH	standard units		(6.5-8.5)[1]	8.2	7.5	7.8	N/A	N/A
Sulfate	mg/l as SO_4		250[1]; 500[2]	49.2	117	83.1	87.5	89.4
Metals/Elements								
Aluminum	mg/l as Al		(0.05-0.2)[3]	0.003	0.024	0.017	0.018	0.019
Antimony	mg/l as Sb	0.006		0.003	0.018	0.031	0.032	0.003
Arsenic (total)	mg/l as As	0.05		0.017	0.04	0.003	0.018	0.020
Barium	mg/l as Pb	2.0		0.036	0.059	0.003	0.050	0.051
Beryllium	mg/l as Be	0.004		0.003	0.001	0.003	0.001	0.001
Boron	mg/l as B			0.158	0.187	0.173	0.182	0.185
Cadmium	mg/l as Cd	0.005		0.0024	0.0024	0.0012	0.0013	0.0013
Chromium (total)	mg/l as Cl	0.5		0.003	0.003	0.003	0.001	0.003
Copper	mg/l as Cl	1.0		0.004	0.003	0.003	0.003	0.003
Iron	mg/l as Pb		0.3[1]	0.202	0.368	0.003	0.300	0.306
Lead	mg/l as Pb	0.015		0.004	0.024	0.004	0.001	0.051
Magnesium	mg/l as Mg		125[1]; 150[2]	19.0	18.3	17.8	18.7	19.1
Manganese	mg/l as Mg		0.05[1]; 0.1[2]	0.004	0.018	0.004	0.003	0.044
Mercury	mg/l as Hg	0.002		0.0002	0.0002	0.0024	0.0001	0.0001
Nickel	mg/l as Ni	0.1		0.017	0.017	0.003	0.009	0.003
Selenium	mg/l as Se	0.05		0.04	0.04	0.02	0.02	0.02
Silver	mg/l as Ag		0.1[3]		0.003	0.002	0.002	0.002
Thallium	mg/l as Tl	0.002		0.001	0.001	0.001	0.001	0.001
Zinc	mg/l as Zn		5.0[3]	0.004	0.004	0.004	0.004	0.004

[1] Nevada Secondary recommended maximum contaminant level

[2] Nevada Secondary (Enforceable) maximum contaminant level

[3] Federal Secondary maximum contaminant level

[4] Grab Sample #FPDSDIS-12

[5] 24-hour composite sample #FPDS June 10 Comp

[6] Calculated concentrations in reinfiltration basins assuming 5 and 7 percent evaporation

Source: SFPG

TABLE A-5
Summary of Meteoric Water Mobility Procedure Test Data for Mine Rock

	Constituent		pH[5]	TDS (mg/L)	Al	Sb	As	Be	Cd	Cl	F	Fe	Mn	Hg	Ni	Se	SO_4	Tl	Zn
South Pit	Drinking Water Standard[1]		6.5-8.5[2]	1000[2]	0.05[4]	0.006	0.05	0.004	0.005	400[3]	4	0.3[2]	0.1[3]	0.002	0.1	0.05	500[2]	0.002	5.0[4]
	Basalt	min	**3.5**	**39**	**0.01**	**0.02**	**0.04**	**0.001**	**0.002**	**0.3**	**0.2**	**0.009**	**0.002**	**0.0001**	**0.04**	**0.001**	**1.58**	**0.04**	**0.004**
	30 Samples	max	8.39	1390	8.75	0.20	4.42	0.020	0.029	108	1.9	65.8	12.30	0.0156	0.06	0.122	904	0.10	0.865
		mean	6.9	310	0.52	0.05	0.34	0.002	0.004	7.2	0.66	3.8	0.06	0.0002	0.02	0.012	155	0.05	0.06
	Exceeding D.W.[1]	n	4	5	11	[6]	13	2	1	0	0	0	7	0	0	2	5	[6]	0
		%	13	17	37	[6]	43	7	3	0	0	13	23	3	13	0	17	[6]	0
	Shale	min	5.0	22	**0.01**	**0.02**	**0.04**	**0.001**	**0.002**	0.6	**0.1**	**0.009**	**0.002**	**0.0001**	0.04	**0.001**	1.55	**0.04**	**0.004**
	28 Samples	max	8.1	2640	0.8	1.3	0.27	0.005	0.011	288	1.1	0.134	19.6	0.002	0.06	0.002	1810	0.1	0.502
		mean	7.3	353	0.10	0.10	0.10	0.002	0.004	17.4	0.41	0.02	0.009	0.0002	0.06	0.026	173	0.06	0.03
	Exceeding D.W.[1]	n	2	2	13	[6]	17	0	1	0	1	0	0	0	0	2	4	[6]	0
		%	7	7	46	[6]	61	0	4	0	4	0	21	0	0	7	14	[6]	0
	Alluvium	min	7.1	56	**0.01**	**0.01**	**0.04**	**0.001**	**0.002**	0.7	0.4	**0.009**	**0.002**	**0.0002**	0.01	**0.001**	3.5	**0.01**	**0.004**
	66 Samples	max	8.6	965	0.53	0.10	1.83	0.005	0.009	400	5.1	0.346	0.080	0.069	0.04	0.04	250	0.20	0.038
		mean	7.8	180	0.03	0.03	0.20	0.002	0.003	15.9	1.01	0.02	0.009	0.009	0.02	0.002	29.4	0.06	0.007
	Exceeding D.W.[1]	n	1	0	6	[6]	27	0	1	0	1	0	0	12	0	0	0	[6]	0
		%	2	0	9	[6]	41	0	2	0	2	2	0	18	0	0	0	[6]	0
	Lherz	min	8.1	97	**0.03**	**0.02**	0.15	**0.001**	**0.004**	0.87	0.7	**0.009**	0.007	**0.0002**	**0.02**	**0.001**	3.76	**0.04**	**0.004**
	2 Samples	max	8.1	97	0.03	0.02	0.22	0.001	0.004	1.5	1.42	0.009	0.031	0.0002	0.02	0.001	6.7	0.04	0.004
		mean	8.1	97	0.03	0.02	0.19	0.001	0.004	1.2	1.1	0.009	0.009	0.0002	0.02	0.009	5.2	0.04	0.004
	Exceeding D.W.[1]	n	0	0	0	[6]	2	0	0	0	0	0	0	0	0	0	0	[6]	0
		%	0	0	0	[6]	100	0	0	0	0	0	0	0	0	0	0	[6]	0
Vista Pit	Constituent		pH[5]	TDS (mg/L)	Al	Sb	As	Be	Cd	Cl	F	Fe	Mn	Hg	Ni	Se	SO_4	Tl	Zn
	Drinking Water Standard[1]		6.5-8.5[2]	1000[2]	0.05[4]	0.006	0.05	0.004	0.005	400[3]	4	0.3[2]	0.1[3]	0.002	0.1	0.05	500[2]	0.002	5.0[4]
	Basalt	min	3.4	55	**0.01**	**0.02**	0.04	**0.001**	**0.002**	0.4	0.1	**0.009**	**0.002**	0.0001	**0.04**	**0.001**	1	**0.04**	**0.004**
	45 Samples	max	8.94	4920	37.3	0.31	1.55	0.036	0.006	83.1	1.8	435	74.8	0.192	0.75	0.466	3280	0.08	5.49
		mean	7.6	251	0.88	0.04	0.22	0.002	0.003	8.5	0.6	10.4	0.06	0.01	0.02	0.03	100	0.04	0.14
	Exceeding D.W.[1]	n	2	1	6	[6]	25	1	1	0	0	1	0	14	0	0	1	[6]	1
		%	4	2	13	[6]	56	2	2	0	0	0	0	31	0	7	0	[6]	0
	Shale	min	7.5	112	**0.03**	**0.02**	0.05	**0.001**	**0.004**	6.4	0.5	**0.009**	**0.002**	0.009	**0.02**	**0.001**	8.2	**0.04**	**0.004**
	2 Samples	max	7.9	1360	0.03	0.03	0.14	0.001	0.004	524	1.7	0.009	0.002	0.0147	0.02	0.001	333	0.04	0.004
		mean	7.7	736	0.03	0.03	0.10	0.001	0.004	265	1.1	0.009	0.002	0.011	0.02	0.009	171	0.04	0.004
	Exceeding D.W.[1]	n	0	1	0	[6]	1	0	0	1	0	0	0	0	0	0	0	[6]	0
		%	0	50	0	[6]	50	0	0	50	0	0	0	100	0	0	0	[6]	0
	Sandstone	min	7.7	57	**0.03**	**0.02**	**0.04**	**0.001**	**0.004**	3.1	**0.1**	**0.009**	**0.002**	**0.0002**	**0.02**	**0.001**	2.5	**0.04**	**0.004**
	5 Samples	max	9.53	167	0.08	0.04	0.24	0.001	0.006	12.0	0.6	0.009	0.009	0.0176	0.02	0.009	10.3	0.04	0.004
		mean	8.2	105	0.04	0.03	0.09	0.001	0.004	6.4	0.3	0.009	0.002	0.0002	0.02	0.002	5.5	0.06	0.004
	Exceeding D.W.[1]	n	1	0	1	[6]	2	0	1	0	0	0	0	0	0	0	0	[6]	0
		%	20	0	20	[6]	40	0	20	0	0	0	0	20	0	0	0	[6]	0
	Limestone	min	7.7	56	**0.03**	**0.02**	**0.04**	**0.001**	**0.004**	0.6	**0.1**	**0.009**	**0.002**	**0.0002**	**0.02**	**0.001**	2.3	**0.04**	**0.004**
	14 Samples	max	8.2	132	0.09	0.04	0.09	0.001	0.004	10.7	0.3	0.009	0.002	0.0002	0.03	0.001	23.2	0.06	0.004
		mean	7.9	96	0.04	0.03	0.05	0.001	0.004	4.5	0.2	0.009	0.009	0.0002	0.02	0.001	8.2	0.06	0.004
	Exceeding D.W.[1]	n	0	0	2	[6]	2	0	0	0	0	0	0	0	0	0	0	[6]	0
		%	0	0	14	[6]	14	0	0	0	0	0	0	0	0	0	0	[6]	0
	Gouge	min	8.0	89	**0.03**	**0.02**	**0.04**	**0.001**	**0.004**	1.6	0.4	0.002	**0.002**	**0.0002**	**0.02**	**0.001**	0.75	**0.04**	**0.004**
	2 Samples	max	8.1	297	1.32	0.02	0.04	0.001	0.004	66.7	0.5	0.009	0.009	0.0013	0.02	0.001	50.3	0.04	0.017
		mean	8.1	193	0.68	0.02	0.04	0.001	0.004	34.0	0.5	0.11	0.004	0.0003	0.02	0.001	26	0.04	0.011
	Exceeding D.W.[1]	n	0	0	1	[6]	0	0	0	0	0	0	0	0	0	0	0	[6]	0
		%	0	0	50	[6]	0	0	0	0	0	0	0	0	0	0	0	[6]	0

[1]Nevada primary maximum contaminant levels in milligrams per liter (unless otherwise noted).
[2]Nevada secondary (recommended) maximum contaminant levels.
[3]Nevada secondary (enforceable) maximum contaminant levels.
[4]Federal secondary maximum contaminant levels.
[5]Standard units.
[6]Detection limits were higher than drinking water standards, so number of exceedances was not calculated.
Note: **Bold** values indicate the minimum value is the detection limit for this constituent. When constituent concentrations were below detection limits, the detection limits were used to calculate a mean value.

APPENDIX B

Wildlife Species Lists

TABLE B-1
Wildlife Species List
Lower Sagebrush/Grassland Steppe
Northeastern Nevada

Common Name	Scientific Name
Birds	
Turkey vulture	Cathartes aura
Bald eagle	Haliaeetus leucocephalus
Northern harrier	Circus cyaneus
Swainson's hawk	Buteo swainsoni
Red-tailed hawk	Buteo jamaicensis
Ferruginous hawk	Buteo regalis
Rough-legged hawk	Buteo lagopus
Golden eagle	Aquila chrysaetos
American kestrel	Falco sparverius
Merlin	Falco columbarius
Prairie falcon	Falco mexicanus
Gray partridge	Perdix perdix
Chukar	Alectoris chukar
Sage grouse	Centrocercus urophasianus
Mourning dove	Zenaida macroura
Great horned owl	Bubo virginianus
Burrowing owl	Athene cunicularia
Short-eared owl	Asio flammeus
Common nighthawk	Chordeiles minor
Broad-tailed hummingbird	Selasphorus platycercus
Northern flicker	Colaptes auratus
Gray flycatcher	Epidonax wrightii
Ash-throated flycatcher	Myiarchus cinerascens
Say's phoebe	Sayornis saya
Western kingbird	Tyrannus verticalis
Horned lark	Eremophila alpestris
Barn swallow	Hirundo rustica
Black-billed magpie	Pica pica
American crow	Corvus brachyrhynchos
Common raven	Corvus corax
Rock wren	Salpinctes obsoletus
Mountain bluebird	Sialia currucoides
American robin	Turdus migratorius
Sage thrasher	Oreoscoptes montanus
Loggerhead shrike	Lanius ludovicianus
Northern shrike	Lanius excubitor
European starling	Sturnus vulgaris
Brewer's sparrow	Pooecetes gramineus
Vesper sparrow	Chondestes grammacus
Lark sparrow	Amphispiza belli
White-crowned sparrow	Zonotrichia leucophrys
Lapland longspur	Calcarius lapponicus
Red-winged blackbird	Agelaius phoeniceus
Western meadowlark	Sturnella neglecta

TABLE B-1
Wildlife Species List
Lower Sagebrush/Grassland Steppe
Northeastern Nevada
(continued)

Common Name	Scientific Name
Birds (continued)	
Brewer's blackbird	Euphagus cyanocephalus
Brown-headed cowbird	Molothrus ater
Black rosy finch	Leucosticte arctoa
Gray-crowned rosy finch	Leucosticte arctoa
House sparrow	Passer domesticus
Mammals	
Little brown bat	Myotis lucifugus
Long-eared myotis	Myotis evotis
Long-legged myotis	Myotis volans
Small-footed myotis	Myotis ciliolabrum
Silver-haired bat	Lasionycteris noctivagans
Western pipistrelle	Pipistrellus hesperus
Big brown bat	Eptesicus fuscus
Townsend's big-eared bat	Plecotus townsendii
Brazilian free-tailed bat	Tadarida brasiliensis
Black-tailed jackrabbit	Lepus californicus
Mountain cottontail	Sylvilagus nuttallii
Pygmy rabbit	Sylvilagus idahoensis
Townsend's ground squirrel	Spermophilus townsendii
Belding ground squirrel	Spermophilus beldingi
Least chipmunk	Tamias minimus
Botta's pocket gopher	Thomomys bottae
Northern pocket gopher	Thomomys talpoides
Little pocket mouse	Perognathus longimembris
Great basin pocket mouse	Perognathus parvus
Dark kangaroo mouse	Microdipodops megacephalus
Ord kangaroo rat	Dipodomys ordii
Chisel-toothed kangaroo rat	Dipodomys microps
Deer mouse	Peromyscus maniculatus
Northern grasshopper mouse	Onychomys leucogaster
Desert woodrat	Neotoma lepida
Sagebrush vole	Lemmiscus curtatus
House mouse	Mus musculus
Kit fox	Vulpes macrotis
Coyote	Canis latrans
Long-tailed weasel	Mustela frenata
Badger	Taxidea taxus
Striped skunk	Mephitis mephitis
Mountain lion	Felix concolor
Bobcat	Lynx rufus
Mule deer	Odocoileus hemionus
Pronghorn	Antilocapra americana

TABLE B-1
Wildlife Species List
Lower Sagebrush/Grassland Steppe
Northeastern Nevada
(continued)

Common Name	Scientific Name
Reptiles	
Western skink	Eumeces skiltonianus
Western whiptail	Cnemidophorus tigrus
Desert collared lizard	Crotaphytus insularis
Long-nosed leopard lizard	Gambelia wislizenii
Desert spiny lizard	Sceloporus magister
Sagebrush lizard	Sceloporus graciosus
Western fence lizard	Sceloporus occidentalis
Side-blotched lizard	Uta stansburiana
Desert horned lizard	Phrynosoma platyrhinos
Short-horned lizard	Phrynosoma douglassii
Long-nosed snake	Rhinocheilus lecontei
Ground snake	Sonora semiannulata
Night snake	Hypsiglena torquata
Gopher snake	Pituophis melanoleucus
Racer	Coluber constrictor
Striped whipsnake	Masticophis taeniatus
Western rattlesnake	Crotalus viridis

Source: Gray 1995.

TABLE B-2
Species Occurrence
Humboldt River Study Database

Species	Number of Occurrences
Birds	
American bittern	
American coot	3
American crow	2
American kestrel	
American robin	2
Barn swallow	1
Bewick's wren	2
Black-billed magpie	4
Black-crowned night heron	4
Black-headed grosbeak	1
Black-necked stilt	1
Blue-winged teal	1
Brewer's blackbird	7
Brown-headed cowbird	1
Bushtit	1
Cinnamon teal	3
Cliff swallow	2
Common nighthawk	
Common raven	1
Common snipe	1
Common yellowthroat	5
Gadwall	2
Great blue heron	2
Great egret	
Green-winged teal	1
Horned lark	1
Killdeer	5
Lark sparrow	2
Lazuli bunting	2
Lesser scaup	1
Loggerhead shrike	1
Mallard	4
Marsh wren	1
Mourning dove	4
Northern mockingbird	
Northern oriole	1
Northern pintail	1
Northern rough-winged swallow	1
Prairie falcon	
Red-tailed hawk	
Redwinged blackbird	10
Sage thrasher	1
Savannah sparrow	3
Song sparrow	7
Sora	1

TABLE B-2
Species Occurrence
Humboldt River Study Database
(continued)

Species	Number of Occurrences
Birds (continued)	
Snowy egret	
Spotted sandpiper	4
Swainson's hawk	
Western kingbird	3
Western meadowlark	6
Willet	1
Yellow warbler	1
Yellow-breasted chat	1
Yellow-headed blackbird	1
Mammals	
Mule deer	
Coyote	
Cottontail rabbit	
Black-tailed jackrabbit	
Porcupine	
Bobcat	
Pygmy rabbit	
Muskrat	
Deer mouse	
House mouse	
Ord's kangaroo rat	
Northern grasshopper mouse	
Little pocket mouse	
Reptiles	
Great basin whiptail	
Desert spiny lizard	

Source: Gebhart 1996.

APPENDIX C

Ecological Risk Assessment

Appendix C
Ecological Risk Assessment

An ecological risk assessment was conducted to identify chemicals in the Twin Creeks Mine pit lake that would pose a potential hazard to wildlife that may consume the pit water, associated vegetation, and invertebrates from the lake. The risk assessment includes an evaluation of the potential risks to wildlife from exposure to these chemicals. The risk assessment was conducted in two stages: a screening-level risk assessment, followed by a baseline risk assessment.

C.1 Screening-Level Risk Assessment

In the screening-level risk assessment, conservative assumptions were made regarding the potential exposure of receptor species to chemical concentrations in the pit lake. As the name implies, the screening-level risk assessment provided a screening to identify chemicals of potential concern that would require further investigation. Chemicals identified as not posing risks were excluded from further consideration.

Two alternative pit lake scenarios were analyzed (the No Action alternative and the Proposed Action), and an ecological risk assessment was conducted for each alternative. The estimated time required for the South Pit to fill to hydrologic equilibrium is approximately 127 years for the No Action alternative and 230 years for the Proposed Action. To identify potential ecological risks during the filling period and at equilibrium, three ecological risk assessment scenarios were developed for each alternative: 5 years after the cessation of mining, 27 years after the cessation of mining, and equilibrium.

The ecological risk assessment was conducted in three phases: (1) problem formulation, (2) exposure and effects characterization, and (3) ecological risk characterization. Each of these phases provided information for the subsequent phase.

C.1.1 Problem Formulation

Problem formulation included the following tasks:

- Site characterization
- Identification of chemicals of potential concern
- Identification of receptor species
- Development of exposure scenarios

This information was used to characterize exposure and effects in the second phase of the ecological risk assessment process.

C.1.1.1 Site Characterization

Site characterization included a description of the physical environment of the lake, such as surface area, filling rate, water depth, wall slope, distance to the rim, and wave action. This information was derived from geological, hydrological, and climatological data.

Characterization of the site included determining site access and potential food availability. At the 127/230-year time period, for example, the lake filling rate would probably slow to a point where shallow zones would exist for extended periods, and littoral vegetation would develop, provided the substrate were appropriate and nutrients were available. Except for sheltered embayments that are protected from wind and wave erosion or very wide benches, most narrow, flat benches would be expected to be covered by steep slopes of scree and talus eroded from the pit wall. Pit lake characteristics for the alternative pit lakes are presented in ***Table C-1***.

For each of the two alternatives, the lake filling rate and the pit wall configuration were used to estimate the type of habitat that would be available at each time interval. The effects of wave action on pit walls were also considered relative to littoral and riparian habitat availability. The predicted habitat conditions for the pit lakes are presented in ***Table C-2***.

During the early stages of filling, the rapid rate at which the water level would increase is predicted to preclude the formation of either littoral or riparian habitat. Steep 20- to 40-foot uneroded bench walls would be expected to dominate shorelines during the early stages of lake development.

At 5 years, both alternative lake configurations would consist of two lakes (north and south). At 27 years, a single lake would have formed under the No Action alternative, while two lakes would still be present under the Proposed Action. At equilibrium, or hydrologic steady state, a single lake would have formed in both pits. The north and south lakes would fill at the same rate, and the potential for lake and riparian habitat to develop would

TABLE C-1
Predicted Pit Lake Characteristics

Parameter	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Number of Lakes	2	1	1
Fill Rate (minimum)	27 feet/year	4.5 feet/year	0.12 foot/year
Depth of Water	362 feet	580 feet	680 feet
Vertical Distance from Pit Rim to Lake Surface	500 feet	280 feet	180 feet
Littoral Substrate	None	None	Small amount present
Trophic State	Possibly eutrophic	Oligotrophic	Oligotrophic
Proposed Action (Equilibrium ≈ 230 years)			
Number of Lakes	2	2	1
Fill Rate (minimum)	24 feet/year	8 feet/year	0.04 foot/year
Depth of Water	200 feet	514 feet	780 feet
Vertical Distance from Pit Rim to Lake Surface	860 feet	530 feet	280 feet
Littoral Substrate	None	None	Small amount present
Trophic State	Possibly eutrophic	Oligotrophic	Oligotrophic

Source: Parametrix 1996.

TABLE C-2
Predicted Pit Lake Habitat Conditions

Parameter	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Littoral Habitat	None	None	Some Present
Riparian Habitat	None	None	Some Present
Upland Habitat	Present	Present	Present
Proposed Action (Equilibrium ≈ 230 years)			
Littoral Habitat	None	None	Some Present
Riparian Habitat	None	None	Some Present
Upland Habitat	Present	Present	Present

Source: Parametrix 1996.

occur at the same rate. Therefore, habitat type and availability would be the same in the north and south lakes.

C.1.1.2 Chemicals of Potential Concern

Chemicals of potential concern were identified from analysis of ground water and geological material sampled at the existing South Pit (PTI 1996a). The chemical concentrations in the future pit lakes were based on a series of laboratory experiments. As the ground water rises in the pit lake, it would come into contact with material of different geologic origin. Characteristics of the material, including solubility and acid-generating potential, would influence the kind and concentration of metals in the water. Consequently, predicted concentrations for some metals would rise or fall because of the sequential inundation of different geologic materials, as well as precipitation (which dilutes chemicals) and evaporation (which concentrates chemicals). No persistent organic chemicals are expected to be present at closure. The following inorganic chemicals were identified as chemicals of potential concern:

- Aluminum
- Antimony
- Arsenic
- Cadmium
- Chromium
- Copper
- Fluoride
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

Other chemicals (e.g., iron and calcium), although present, were not included as chemicals of potential concern since geochemical studies determined that they would be present at very low concentrations, relative to toxicity levels and background concentrations and/or they are considered essential nutrients for plants and animals (Parametrix 1996).

C.1.1.3 Receptor Species

Parametrix (1996) selected receptor species for the ecological risk assessment to represent certain functional groups, taxonomic levels, trophic levels, habitats, and body sizes. Threatened or endangered species were also considered. Six species, four birds and two mammals, were chosen as receptor species for this ecological risk assessment. These species are presented in ***Table C-3***.

The mallard was selected to represent waterfowl that may breed, winter, or stop over at the pit lake during migration. The mallard may drink from the pit lake and forage on both aquatic plants and invertebrates. The spotted sandpiper represents shorebirds that may drink from the pit lake and feed on aquatic invertebrates found along the lake shoreline. The cliff swallow was selected to represent passerine birds, especially aerial feeders, that may drink from the pit lake and forage on emergent aquatic insects. The bald eagle was considered as the receptor species for raptors because it is a federally threatened species that occurs in northern Nevada; migrating bald eagles move through the state and may occupy winter habitats in Nevada. The little brown myotis (bat) was selected to represent small, insect-eating mammals, which may drink from the pit lake, forage on emergent aquatic insects, and breed and roost on the rocky walls of the pit. The mule deer was selected as the receptor species for large mammals; mule deer are relatively common in the pit lake vicinity and may be at risk if they were to drink water from the pit lake. The mule deer is a food source for carnivores, scavengers, and humans. These species were chosen following a review of data on the wildlife resources in the project area and consultation with the applicable resource agencies.

Parametrix (1996) determined that two of the potential receptor species, the bald eagle and the mule deer, would be either subject to negligible risk, or the exposure pathways would be incomplete. Therefore, these two organisms were eliminated from further examination. A brief discussion of the rationale for removing these animals from consideration is discussed below.

The primary route of exposure for bald eagles would be through food consumption. However, Parametrix (1996) assumed that the bald eagle would not likely be exposed to chemicals of potential concern via a food pathway for the following reasons:

- Bald eagles do not currently nest in Nevada and, therefore, would not be present most of the year.
- Bald eagles generally concentrate their fishing efforts in shallow areas of water bodies; under the No Action alternative and the Proposed Action, these areas would be limited in the future pit lake.
- Wintering bald eagles that occur in Nevada primarily occupy portions of western Nevada and the Ruby Lake area.
- Wintering bald eagles typically feed on waterfowl and mammals, which were assumed not to be prevalent at the pit lake.

TABLE C-3
Receptor Species

Mammals		Birds	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Little Brown Myotis	*Myotis lucifugus*	Mallard Duck	*Anas platyrhynchos*
Mule Deer	*Odocoileus hemionus*	Spotted Sandpiper	*Actitis macularia*
		Cliff Swallow	*Hirundo pyrrhonota*
		Bald Eagle	*Haliaeetus leucocephalus*

- More favorable foraging opportunities would exist away from the pit lake at Chimney Reservoir (if not dry), the Humboldt River, Kelly Creek, other creeks, and several stock ponds.

- Fish populations are unlikely to develop in the pit lake to a degree that would support bald eagles due to the (1) oligotrophic (limited food) nature of the lake, (2) limited shallow littoral regions that would act as spawning habitat, (3) lack of suitable substrate for spawning, and (4) lack of cover for fry (i.e., little, if any, vegetation and few protected embayments).

- Favorable roosting trees for bald eagles (tall trees) would not occur within several miles of the pit lake. Bald eagles, particularly juveniles, tend to wander in the winter to various foraging areas. Adult bald eagles generally prefer feeding areas with high concentrations of prey, and often those areas are along marshes and rivers.

Mule deer are unlikely to have access to lake waters. During the summer, for example, mule deer are expected to move to higher areas in the Osgood and Snowstorm mountain ranges. Mule deer in the vicinity of the pit lake would most likely limit water ingestion to more easily accessible streams (e.g., Kelly Creek) and stock ponds. The sheer walls of the pit lake (an estimated 100 feet from the rim to the water's surface at equilibrium) and SFPG's proposed measures to limit access (e.g., blasting pit access roads) would also restrict mule deer from reaching the water.

Based on these biological assumptions, Parametrix (1996) eliminated both the bald eagle and mule deer from further ecological risk assessment.

C.1.1.4 Exposure Scenarios

It is necessary to identify the pathways through which a chemical of concern could come into contact with a receptor species. To be included in a potential exposure pathway, the chemical must be bioavailable, and there must be an identifiable route from source to receptor (i.e., complete pathway). The exposure pathways used in the ecological risk assessment are summarized in ***Table C-4***. To minimize the formation of habitats that could increase the availability of food for receptor species and to limit access to the water source, SFPG proposes the following risk management actions:

- Shallow areas and protected embayments (coves) would be minimized, based on the final engineering design.

- Pit access roads would be removed.

Because of the lack of access roads and the steep, unstable pit walls, access to the pit lake water would be difficult.

It is predicted that the pit lake would be slightly eutrophic at 5 years and oligotrophic for the remainder of the filling period. The term eutrophic (literally, "well-fed") indicates that the lake would be sufficiently high in nutrients (primarily nitrogen and phosphorus) to promote primary production (algae and macrophytes). Because of the rapid filling of the lake during early lake development, however, production should be almost exclusively algal, not macrophytic. Macrophyte growth would be further discouraged by the limited amount of protected embayments (which would protect plants from harsh wave action), presence of steep slopes, and the probable absence of fine substrates needed for root attachment. At 27 years and beyond, the lake would be oligotrophic (literally, "few-fed") and less productive.

Based on previous studies in Nevada pit lakes (PTI and RCI 1996), phytoplankton, zooplankton, and macroinvertebrate populations would be expected to develop in the No Action alternative and Proposed Action pit lakes. During the initial development of the pit lake at 5 years, macroinvertebrate production would likely be limited to low numbers of deep water chironomid midges and oligochaete worms because of the lack of a littoral zone and very limited food supply in the form of organic matter. Other invertebrate groups would be expected to colonize the pit lake at 27 years and at equilibrium, as limited littoral areas develop. However, macroinvertebrate densities would likely be relatively low, since macrophyte growth would be minimal. Phytoplankton and zooplankton (cladocerans, copepods, and rotifers) populations would gradually increase throughout the development of the lake. Many aquatic insects exist as juveniles underwater, emerging as winged adults to breed (e.g., chironomids). The very low numbers of aquatic juveniles, therefore, severely limits the number of adults on which birds and bats could

TABLE C-4
Exposure Pathways

Species	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Mallard	Food, Water	Water	Water
Spotted Sandpiper	Food, Water	Food/Water	Food/Water
Cliff Swallow	Food, Water	Food/Water	Food/Water
Little Brown Myotis	Food, Water	Food/Water	Food/Water
Proposed Action (Equilibrium ≈ 230 years)			
Mallard	Food, Water	Water	Water
Spotted Sandpiper	Food, Water	Food/Water	Food/Water
Cliff Swallow	Food, Water	Food/Water	Food/Water
Little Brown Myotis	Food, Water	Food/Water	Food/Water

Source: Parametrix 1996

feed. However, because some aquatic macroinvertebrates capable of living in deeper water may be present at 5 years, both food and water routes of exposure were considered in the 5-year scenarios for those receptor species that would consume insects and other invertebrates.

Another consideration in constructing the exposure scenarios was whether the exposure would be acute (short-term) or chronic (long-term). Acute exposure would occur if organisms stop or rest in the exposure area for short periods of time. For chronic exposure to occur, organisms would likely remain in the exposure area over an extended period of time. Often this would entail breeding and nesting in the exposure area. A summary of the anticipated acute/chronic exposure routes is provided in ***Table C-5***.

The individual receptor organisms were evaluated for their likelihood of chronic exposure.

Mallard

No chronic exposure was anticipated for mallards in the ecological risk assessment because (1) there would be a lack of sufficient cover for nesting and brooding within approximately 100 yards of the pit, (2) there would likely be insufficient shallow aquatic vegetation upon which birds could feed, and (3) mallards are not expected to overwinter at the pit lake due to lack of cover, insufficient food supply, and the presence of more attractive habitat nearby.

Mallards may stop over at the pit lake during migration in the spring and fall and thus may be exposed to acute levels of toxicants.

Spotted Sandpiper

Spotted sandpipers, which feed along shorelines, would be expected to forage along the edge of the lake and ingest water from the lake. They may also breed in the exposure area. Since it is possible that some aquatic invertebrates (e.g., chironomids, which would emerge as winged adults) would be present at all stages of lake development, including 5 years, chronic exposure through both food and water was assumed for this organism.

Cliff Swallow

Swallows, including the cliff swallow, would be expected to nest in and on the pit walls. Since swallows construct their nests primarily from mud, incidental ingestion of water while collecting mud could occur, along with direct ingestion from drinking. As discussed for the spotted sandpiper, it is possible that some aquatic invertebrates may be present at all stages of lake development. Therefore, chronic exposure through both food and water was assumed for this organism.

Little Brown Myotis

Bats would be expected to colonize openings in the pit walls. As mentioned above, some aquatic invertebrates may be present at all lake stages. Chronic exposure through both food and water was assumed for this organism.

C.1.2 Exposure Assessment

For each wildlife receptor having a complete exposure pathway, chemical doses were estimated

TABLE C-5
Acute and Chronic Exposure Routes

Species	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Mallard	Acute	Acute	Acute
Spotted Sandpiper	Chronic	Chronic	Chronic
Cliff Swallow	Chronic	Chronic	Chronic
Little Brown Myotis	Chronic	Chronic	Chronic
Proposed Action (Equilibrium ≈ 230 years)			
Mallard	Acute	Acute	Acute
Spotted Sandpiper	Chronic	Chronic	Chronic
Cliff Swallow	Chronic	Chronic	Chronic
Little Brown Myotis	Chronic	Chronic	Chronic

Source: Parametrix 1996

by using predicted water concentrations and receptor-specific body weights and ingestion rates. As part of the conservative nature of the screening-level risk assessment, it was assumed that all water and/or food would come from the pit lake.

For the spotted sandpiper, cliff swallow, little brown myotis, and mallard at 5 years, both water and food exposure routes were considered in calculating the chemical dose. For the mallard at 27 years and at lake equilibrium, only the water dose was considered (due to the predicted oligotrophic state of the lake). The dose from food was estimated by multiplying the water concentration by a bioconcentration factor, as illustrated in the following equation:

$$EED = ((C_{water} * BCF * IR_{food}) + (C_{water} * IR_{water}))/BW$$

where:

EED = expected environmental dose of a chemical from food and water (milligrams/kilogram/day)
C_{water} = chemical concentration in water (milligrams/liter)
BCF = bioconcentration factor (liters/kilogram)
IR_{food} = ingestion rate of food (kilograms/day)
IR_{water} = ingestion rate of water (liters/day)
BW = body weight of receptor (kilograms)

Food and water ingestion rates were derived from the literature or calculated using allometric equations obtained from U.S. Environmental Protection Agency sources. For example, the equation to calculate food ingestion in birds is:

$$IR_{food} = 0.0582 * BW^{0.651}$$

where:

IR_{food} = ingestion rate of food (kilograms/day)
BW = body weight of receptor (kilograms)

Table C-6 summarizes the assumed values used to calculate chemical dose.

Bioconcentration factors were determined using both historical laboratory studies as well as data from a pit lake analog study (PTI and RCI 1996). In the analog study, existing Nevada pit lakes were examined for chemical and physical parameters, including chemical concentrations in water and body tissue. If multiple sources of data were found, either from the field study or from literature-based laboratory studies, the geometric mean of the bioconcentration factors was calculated and used in the screening-level risk assessment. The invertebrate and plant bioconcentration factors used in the screening-level risk assessment are presented in ***Table C-7***.

Ecological effects levels, or doses, are toxicological benchmark values that are expected to result in no adverse effects on the receptor organism. The no-adverse-effect levels may be for chronic or acute (lethal) exposure. No U.S. Environmental Protection Agency criteria or state of Nevada standards currently exist for wildlife. Therefore, the benchmark values used in the screening-level risk assessment were derived from the scientific literature. Acute toxicity data were generally presented as LD_{50}s (the dose of

TABLE C-6
Values Used to Calculate Chemical Dose

Parameter	Species			
	Little Brown Myotis	Mallard	Cliff Swallow	Spotted Sandpiper
Ingestion rate of food (IR_{food}, kg/day)	0.00267	0.066	0.0058	0.00745
Ingestion rate of water (IR_{water}, L/day)	0.00118	0.067	0.0047	0.0072
Body weight (kg)	0.0073	1.2	0.023	0.043
100 Percent of diet	Insects	Plants	Insects	Insects

Source: Parametrix 1996

TABLE C-7
Bioconcentration Factors

Chemical	Invertebrate Bioconcentration Factors	Plant Bioconcentration Factors
Aluminum	90.9	0.7
Antimony	4.5	1.3
Arsenic (V)	5.9	314.6
Cadmium	53.2	289.4
Chromium	1.0	289.4
Copper	539.1	73.5
Fluoride	2.3	76.0
Lead	90.9	9.7
Manganese	1800.0	76.0
Mercury (inorganic)	1612.0	438.7
Nickel	72.4	891.5
Selenium (VI)	15.7	6.3
Silver	16.8	15.5
Thallium	34.0	76.0
Zinc	560.6	684.5

Source: Parametrix 1996

a chemical that causes 50 percent mortality in the test organisms); chronic endpoints included no-observed-adverse-effect levels for such things as survival, reproduction, and growth. Since the number of species for which toxicity data are available is generally quite limited, data from surrogate species were often used. For example, avian effects levels may have been derived from laboratory tests using chickens or ducks.

C.1.3 Ecological Risk Characterization

To characterize the risk in this screening-level risk assessment, the estimated exposure doses were compared to the estimated ecological effects levels to yield a quantitative evaluation of potential risk to wildlife. The resulting ratio is known as a hazard quotient (Barnthouse et al. 1986; Suter 1993). The hazard quotient equation is given below:

Hazard Quotient = expected environmental dose/ toxicological benchmark value

A hazard quotient less than 1.0 indicates that the dose of a chemical that an organism would receive is less than the level that could cause adverse effects. Therefore, a hazard quotient less than 1.0 indicates that toxicity is unlikely to occur given the conservative nature of screening-level risk

assessments. For example, exposure is considered high (assuming all water and food, for example, comes from the pit lake), and adverse effect levels are low (use of the lowest no-observed-adverse-effect levels, for example).

If a hazard quotient is calculated to be greater than 1.0, then the concentration of a contaminant expected to occur in the environment is greater than levels found in laboratory or field studies to cause no adverse effects to a receptor organism. A hazard quotient greater than 1.0 does not necessarily imply that adverse effects would occur. This is especially true in this screening-level risk assessment where the lowest-observed-adverse-effect level was used as the effects threshold. The lowest-observed-adverse-effect level is the lowest effects threshold available in the literature. The use of a more realistic (higher) effects threshold would result in a lower hazard quotient. A hazard quotient greater than 1.0, therefore, is an indicator that a chemical should be considered a chemical of potential concern, and further evaluation is required.

The magnitude of the hazard quotient is important. Because of the conservative nature of a screening-level risk assessment, hazard quotients between 1.0 and 10.0 are often not considered indicative of significant risk, while hazard quotients greater than 10.0 indicate a potentially significant risk. The assumptions used to calculate the hazard quotients (e.g., adverse effects levels) must be considered when interpreting the results. The more conservative the assumptions, the less likelihood that a hazard quotient greater than 1.0 indicates a tangible risk.

For the mallard, no hazard quotients exceeded 1.0 for any of the time periods modeled for the No Action alternative or the Proposed Action pit lakes. The receptor species for which one or more hazard quotients exceeded 1.0 are listed in ***Table C-8***.

The screening-level risk characterization identified the following wildlife receptors and chemicals of potential concern for further analysis in a baseline risk assessment:

- The little brown myotis (bat species) was found to be potentially at risk from exposure to aluminum, antimony, arsenic, selenium, thallium, and zinc.
- The cliff swallow was found to be potentially at risk from exposure to antimony, selenium, and thallium.
- The spotted sandpiper was found to be potentially at risk from exposure to antimony and selenium.

Based on these results, a baseline risk assessment was conducted to further evaluate the potential ecological risks of these chemicals in the Twin Creeks Mine pit lake.

C.1.4 Uncertainty Analysis

As with most risk assessments, the screening-level risk assessment conducted for the Twin Creeks Mine has several uncertainties. The uncertainties are related to assumptions regarding exposure (including bioavailability and bioconcentration factors) and toxicological benchmark (i.e., no effect level) values. The uncertainties contribute to the possibility that the risk to receptors may be over- or under-estimated. The sources of uncertainty in the Twin Creeks Mine screening-level risk assessment are shown in ***Table C-9***.

The first two uncertainty factors assume not only that all food and water would come from the pit lake, but that all chemicals would be bioavailable. It is highly unlikely that all food and water would come from the pit lake, especially considering that other water sources (e.g., the Humboldt River) are available in the area. It is also unlikely that chemicals would be 100 percent bioavailable. Most metals tend to bind to sediments and suspended particulates and are not available for uptake into body tissue. While it is possible that the uncertainty related to other factors, including dose and benchmark values, could underestimate risk, the conservative nature of the screening-level risk assessment should compensate for any underestimations.

C.2 Baseline Risk Assessment

The purpose of the baseline ecological risk assessment was to further examine the chemicals of concern that have the potential for adverse effects based on the results of the screening-level risk assessment. The baseline risk assessment re-evaluated key assumptions used in the screening-level risk assessment and refined these

TABLE C-8
Hazard Quotients for Affected Species[1,2]
Screening-Level Risk Assessment

No Action Pit Lake					
		5 Years			
Receptor	Chemical	North	South	27 Years	Equilibrium (127 Years)
Little Brown Myotis	Aluminum	1.00	0.12	0.49	0.48
	Antimony	45.70	3.76	20.60	36.71
	Arsenic	0.72	0.57	0.72	1.49
	Selenium	4.70	1.27	2.38	2.47
	Thallium	1.36	0.38	0.72	1.20
	Zinc	0.96	1.22	0.84	0.72
Cliff Swallow	Antimony	34.03	2.80	15.34	27.33
	Selenium	2.53	0.68	1.28	1.33
Spotted Sandpiper	Antimony	24.34	2.00	10.97	19.55
	Selenium	1.77	0.48	0.90	0.93

Proposed Action Pit Lake						
		5 Years		27 Years		Equilibrium
Receptor	Chemical	North	South	North	South	(230 Years)
Little Brown Myotis	Aluminum	1.03	0.04	0.64	0.05	0.23
	Antimony	45.80	3.77	50.34	3.55	31.67
	Arsenic	0.63	1.02	1.40	0.97	1.90
	Selenium	5.59	0.58	3.11	0.54	1.42
	Thallium	1.51	0.26	1.48	0.22	1.02
	Zinc	1.04	0.65	0.55	0.72	0.69
Cliff Swallow	Antimony	34.10	2.81	37.49	2.64	23.58
	Selenium	3.01	0.31	1.67	0.29	0.77
	Thallium	1.05	0.18	1.03	0.15	0.71
Spotted Sandpiper	Antimony	24.39	2.01	26.81	1.89	16.87
	Selenium	2.11	0.22	1.17	0.20	0.54

[1]Hazard quotients are unitless; they were rounded to two decimal places.
[2]Species and chemicals for which one or more hazard quotient exceeded 1.
Source: Parametrix 1996.

TABLE C-9
Sources of Uncertainty in the Screening-Level Risk Assessment

Sources of Uncertainty	Effect of Uncertainty
Assumed 100 percent bioavailability of chemicals	Overestimate of risk
Assumed 100 percent of food and water intake from pit lake	Overestimate of risk
Invertebrate and plant bioconcentration factors	Over- or underestimate of risk
Receptor ingestion rates	Over- or underestimate of risk
Receptor body weights	Over- or underestimate of risk
Toxicological benchmark values	Over- or underestimate of risk
Predicted concentration of chemicals in lake water	Over- or underestimate of risk

Source: Parametrix 1996.

assumptions to produce a more realistic estimation of potential risk.

The screening-level risk assessment included assumptions that resulted in uncertainties about the risk estimations. These uncertainties are described in Section C.1.4 and are summarized in ***Table C-9***. In general, these assumptions resulted in an overestimation of risk to receptor species. In the baseline risk assessment, some of the assumptions were modified to provide what is believed to be more realistic estimations of exposure and/or effects. Three quantitative changes were made in the baseline risk assessment:

- **Ecological Effects Characterization - No-Observed-Adverse-Effect Level for Antimony**. In the screening-level risk assessment, the no-observed-adverse-effect level used for antimony was 0.035 milligrams/kilogram per day, which was derived from a rat study involving longevity. In the baseline risk assessment, a no-observed-adverse-effect level of 2 milligrams/kilogram per day was used. This value was obtained from a study of ewes and lambs in which reproduction was the endpoint to represent a population-level impact. Since protection of populations, rather than individual organisms, is the critical goal of an ecological risk assessment, it was determined that the ewe reproduction study more appropriately represented potential impacts to wildlife populations.

- **Ecological Effects Characterization - Threshold Value**. In the screening-level risk assessment, the no-observed-adverse-effect level was used as the concentration below which no adverse effects are anticipated to occur. The actual concentration at which effects do occur lies somewhere between the no-observed-adverse-effect level and the lowest-observed-adverse-effect level. This concentration, sometimes referred to as the chronic value, can be estimated by calculating the mean of the no-observed-adverse-effect level and the lowest-observed-adverse-effect level. The resulting dose was referred to as the toxicity reference value and was used to calculate hazard quotients in the baseline risk assessment. The use of the mean of the no-observed-adverse-effect level and lowest-observed-adverse-effect level to calculate a hazard quotient results in a more realistic, though still conservative, estimation of risk.

- **Ecological Exposure Assessment - Food Ingestion for Bats**. In the screening-level risk assessment, the food ingestion rate for the little brown myotis was assumed to be 0.37 kilograms/kilogram-day, which is an average value from several ages of bats. The baseline risk assessment used a higher ingestion rate of 0.48 kilograms/kilogram-day, which is the maximum ingestion rate of a lactating female. This higher rate results in a higher estimate of dose to the bat. In addition, the assumption regarding the bat's foraging range was adjusted to include both the northern and southern lakes, when both lakes would exist (e.g., at 5 years).

Using the revised estimates of exposure and effects, new hazard quotients were calculated for the chemicals and species that were found to be at potential risk in the screening-level risk assessment.

The recalculated hazard quotients for the baseline risk assessment are presented in ***Table C-10***.

The only hazard quotients greater than 1.0 were for the little brown myotis for the metal selenium. These hazard quotients occurred in Year 5 of lake development for both the No Action alternative and Proposed Action North Pit lakes. The selenium hazard quotients are not considered significant because of their magnitude (they were barely over 1.0), the knowledge that these hazard quotients were not statistically distinguishable from 1.0 because of the uncertainties inherent in the assumptions and calculations, and understanding that the toxicity reference values were conservative values given the use of safety factors in their derivation. For example, while a hazard quotient of 1.1 was based on selenium concentrations in the north lake of the No Action alternative pit at 5 years (***Table C-10***), the projected foraging of the bat over both the south and north pit lakes would result in an average hazard quotient of 0.7. Additionally, whereas a hazard quotient of 1.3 was associated with the selenium concentrations predicted for the north lake of the Proposed Action pit at 5 years (***Table C-10***), the projected foraging of the bat over both the south and north pit lakes would result in an average hazard quotient of 0.7. No risks to other receptor organisms were identified.

TABLE C-10
Hazard Quotients for Affected Species[1]
Baseline Risk Assessment

No Action Pit Lake					
		5 Years			Equilibrium
Receptor	Chemical	North	South	27 Years	(127 Years)
Little Brown Myotis	Aluminum	0.24	0.03	0.12	0.11
	Antimony	0.19	0.02	0.08	0.15
	Arsenic	0.17	0.13	0.17	0.35
	Selenium	1.11	0.30	0.56	0.58
	Thallium	0.32	0.09	0.17	0.07
	Zinc	0.23	0.29	0.20	0.17
Cliff Swallow	Antimony	0.11	0.009	0.05	0.09
	Selenium	0.46	0.12	0.23	0.24
	Thallium	0.17	0.05	0.09	0.04
Spotted Sandpiper	Antimony	0.08	0.006	0.04	0.06
	Selenium	0.32	0.09	0.16	0.17

Proposed Action Pit Lake						
		5 Years		27 Years		Equilibrium
Receptor	Chemical	North	South	North	South	(230 Years)
Little Brown Myotis	Aluminum	0.25	0.009	0.15	0.01	0.05
	Antimony	0.19	0.02	0.20	0.01	0.13
	Arsenic	0.15	0.24	0.33	0.23	0.44
	Selenium	1.32	0.14	0.73	0.13	0.34
	Thallium	0.36	0.06	0.35	0.05	0.06
	Zinc	0.25	0.16	0.13	0.17	0.16
Cliff Swallow	Antimony	0.11	0.009	0.12	0.008	0.08
	Selenium	0.55	0.06	0.30	0.05	0.14
	Thallium	0.19	0.03	0.19	0.03	0.03
Spotted Sandpiper	Antimony	0.08	0.006	0.09	0.006	0.05
	Selenium	0.38	0.04	0.21	0.04	0.10

[1] Hazard quotients are unitless.
Source: Parametrix 1996.

Based on these study assumptions, available data in the literature, and the likelihood of exposure, the baseline risk assessment indicated that none of the receptor organisms would be at risk from the Twin Creeks Mine No Action alternative and Proposed Action pit lakes. Therefore, no impacts to aquatic or terrestrial wildlife species from acute or chronic exposure to future pit lake water have been identified.

APPENDIX C ATTACHMENTS

Ecological Risk Assessment

Appendix C Attachments

Attachment 1 - Selection of Antimony Endpoint Studies

Selection of the Rat Study for the Screening-Level Risk Assessment

The rat study (Schroeder et al. 1970) was used in the screening-level risk assessment because of its application by the EPA in developing the antimony drinking water criterion for human health (EPA 1992b) and to efficiently screen chemicals, and thus it was not initially reviewed as to its applicability for the ecological risk assessment. The relevant elements of this study are outlined below:

- Rats were exposed to antimony (III) potassium tartrate (the most toxic form of antimony [EPA 1992b] in drinking water for their entire lifetime (approximately 1,000 days) (Schroeder et al. 1970).
- Differences were observed between control and antimony-exposed rats in serum glucose and cholesterol levels as well as a reduction in the overall lifespan of exposed rats. The life span of male rats was reduced 13.9 percent (over a span of 3 years), while the life span of female rats was reduced 5.9 percent over this same time period (Schroeder et al. 1970).
- No differences were observed in heart weight, body weight, or tumor incidence in exposed rats at time of death.

Baseline Risk Assessment Review of the Rat Study

The assumptions and studies used in the screening-level risk assessment were reviewed for applicability and sources of uncertainty in the baseline risk assessment. In particular, a number of studies that addressed the toxicity of antimony to wildlife were reviewed to further evaluate the applicability of the rat study (which was used to develop a criterion to protect individuals). These studies are described below:

- The baseline risk assessment identified the rat longevity reduction endpoint as a major source of uncertainty in extrapolating to a population-level endpoint. For some toxicological endpoints, it is possible to extrapolate between toxicity endpoints when data are available to support this process. For example, EPA guidance allows the extrapolation of acute endpoints (mortality) to chronic endpoints (reduced reproduction) using Acute Chronic Ratios (Stephan et al. 1985). However, no such guidance is available from EPA or the scientific literature to predict whether extrapolations from longevity reduction to reproduction reduction would increase or decrease the toxicity value. Therefore, use of a longevity reduction endpoint to estimate population-level endpoints introduces an unknown and potentially large level of uncertainty into this risk assessment.
- The baseline risk assessment indicated that extrapolating toxicity *between species* for *differing endpoints* does not have a scientifically defensible basis at this time.

Predicted Impact of Longevity Reduction on Bat Populations

The baseline risk assessment effort concurrently evaluated the impact of longevity reduction and the timing of mortality on maintaining populations of the little brown myotis (*Myotis lucifugus*). Results of the evaluation are given below:

- Douben and Siebel (1993) indicate that "*Assuming first no effect on reproduction, and secondly that substance-induced mortality takes place after the breeding season but before natural density-dependent mortality, the extent of normal mortality will be less severe thus, at least partially, compensating for the extra deaths.*"
- Review of the population biology of the little brown myotis indicated that a 6 to 14 percent reduction in overall lifespan would likely have little or no impact on maintaining the population of these animals. These bats have lifespans of up to 29 years (Hill and Smith 1992), with yearling bats having a 40 to 80 percent survival rate to reach 7 or 8 years (Hill and Smith 1992). Bats, in general, are long-lived mammals (particularly for their size), with field banded individuals capable of surviving 18 years and typically becoming

TABLE C1-1
Projected Reductions in Little Brown Myotis Longevity

Projected Life Span of Non-Antimony Exposed Myotis	Predicted Life Span of Antimony-Exposed[1] Female Myotis	Predicted Life Span of Antimony- Exposed[1] Male Myotis
6	5.6	5.2
7	6.6	6.0
8	7.5	6.9

[1]This assumes that little brown myotis exposed to 0.35 mg/kg/day exhibit the same response as rats in the Schroeder et al. (1970) study.

reproductive in their second year (Hill and Smith 1992).

- Projected reductions in little brown myotis longevity as observed in the Schroeder et al. (1970) study were calculated and are presented in ***Table C1-1***. Postulating a similar response to antimony as the rat study, little brown myotis exposed to the lowest-observed-adverse-effect-level value of 0.35 mg/kg/day would still have multiple opportunities to reproduce and maintain population levels.

Selection of the Ewe Study for the Baseline Risk Assessment

Review of the Schroeder et al. (1970) rat study for its applicability to the baseline risk assessment concluded that (1) a significant level of uncertainty existed in the screening-level risk assessment from extrapolating between endpoints for different species using Schroeder et al. (1970) and (2) this effect endpoint (longevity reduction) would have little or no influence on little brown myotis population levels. Thus, a more realistically appropriate antimony endpoint study, (James et al. 1966) described below, was selected for the baseline risk assessment.

- This study administered 2.0 mg/kg/day of antimony (III) potassium tartrate to yearling ewes for the first 45 days of gestation or for the full gestation period (154 to 155 days). This study found no adverse impact on sheep reproduction at this dose for either exposure time period (James et al. 1966).

- Review of the aforementioned ewe study by EPA indicated that the reason it was not used to establish the human Drinking Water Effects Level was that it did not establish a toxic level lowest-observed-adverse effect (EPA 1992b), only a no-observed-adverse-effect level. EPA requires the establishment of both a lowest-observed-adverse-effect level and no-observed-adverse-effect level so that the adopted criteria are representative of the actual level that results in toxicity. For purposes of this EIS, a no-observed-adverse-effect level was considered sufficient to establish a conservatively protective level for assessing risks to wildlife populations.

- The baseline risk assessment concluded that using this antimony no-observed-adverse-effect level would be more appropriate while still being conservative[1] in establishing a population-level reproductive effects endpoint.

Introduction of New Extrapolation Uncertainty

In going from a study of rats (similar in body size to bats and birds) to a ewe study in the baseline risk assessment, a new source of uncertainty was introduced: inter-species extrapolation for the same endpoint. However, in contrast to the earlier discussion of extrapolating between endpoints, the practice of extrapolating between species for the same endpoint is well established in biology in general (Davidson et al. 1986) and specifically for toxicology (Chappell 1992; Watanabe et al. 1992). Additionally:

- Watanabe et al. (1992) have developed a procedure to calculate confidence intervals for extrapolating (termed allometric scaling) toxic effects between different species. This technique was not applied in the baseline risk

[1]The use of this no-observed-adverse-effect level value would be considered conservative as no lowest-observed-adverse-effect level was established in this study. Thus the true no-observed-adverse-effect level is likely to be higher than this value.

assessment since quantification of this type of uncertainty would not have affected the conclusions.

- The adoption of a reproductive endpoint with demonstrated relevance to population maintenance does reduce the uncertainty present in the screening-level risk assessment of antimony.

- The reduction in uncertainty concerning the potential risk to wildlife from antimony resulted from two elements:

  - Sound, scientific support for the extrapolation of the same effect endpoint between species, and

  - Quantifiable estimation of uncertainty in the extrapolation between species.

Result of Ewe to Bat Effects Extrapolation

The uncertainty of the inter-species extrapolation was not quantified in the baseline risk assessment since the sheep-dosing level was adequate to demonstrate that the predicted antimony concentrations in the lake would not pose risks to wildlife (Parametrix 1996). The actual allometric scaling of the sheep dose to the dose a bat would receive would actually result in an increase in the no-observed-adverse-effect level used[2]. Thus, the no-observed-adverse-effect level used in the baseline risk assessment still represents a conservative approach for estimating the potential risks to wildlife from antimony in the future pit lake.

Result of Adopting Ewe Study

In summary, adopting a reproductive no-observed-adverse-effect level for a species with a greater susceptibility to toxicity provides a more reliable estimate of the bat's risk from antimony exposure because it eliminates the uncertainty associated with extrapolating from longevity reduction to a population-level endpoint.

[2] Larger animals are typically more susceptible to toxicity on a mg/kg body weight basis. This is because "*...the different response of larger animals is related to the slower metabolic and clearance rates for larger animals which give rise to larger biological half-lives for chemicals in the body and to higher tissue concentrations per dose*" (Chappell 1992).

Attachment 2 - Bald Eagle Drinking Rates

Bald eagle drinking rates were estimated using the allometric scaling equation for bird ingestion rates for water (Parametrix 1996, as taken from EPA 1993a) and the body size of average female bald eagles (Stalmaster 1987):

$$\textit{Bird Ingestion Rate}_{water} = 0.059 * \textit{Body Weight (kg)}^{0.67}$$

The estimated drinking rate (0.18 L/day) was independently confirmed using the approach outlined for bald eagles in the wildlife exposure handbook (EPA 1993b). Estimated doses from drinking pit lake water and avian toxicity data (Parametrix 1996) were used to calculate hazard quotients. These hazard quotients indicated that individual bald eagles would not be at risk from any of the lake constituents (see attached ***Tables C2-1*** to ***C2-4***). To demonstrate risk, a hazard quotient must be greater than or equal to 1.0; the highest hazard quotient measured for individual bald eagles was 0.003 (selenium VI in the north lobe for the Proposed Action at 5 years (see ***Table C2-4***).

TABLE C2-1
Exposure Assumptions for the Bald Eagle in the Twin Creeks Mine No Action and Proposed Action Pit Lakes: Baseline Risk Assessment

	BW (kg)	IRw (L/d)	IRf (kg/d)
Bald Eagle	5.268	1.8E-1	1.7E-1

BW = Body weight
IRw = Water ingestion rate
IRf = Food ingestion rate

TABLE C2-2
Avian Toxicity Data for the Twin Creeks Mine No Action and Proposed Action Pit Lakes: Baseline Risk Assessment

Constituent	Avian LD50 (mg/kg-d)	Avian NOAEL (mg/kg-d)
Aluminum	261	343
Antimony	115	0.035
Arsenic (V)	323	4
Cadmium	350	0.072
Chromium	13	0.07
Copper	300	8.3
Fluoride	66	13.2
Lead	256	0.072
Manganese	410	122.4
Mercury (Inorganic)	26	0.37
Methylmercury	2	0.0064
Nickel	66	4
Selenium (VI)	1	0.055
Silver	1680	22.2
Thallium	32	0.2
Zinc	2510	139

LD50 = Mean lethal dose
NOAEL = No-observed-adverse-effect level

TABLE C2-3
Water Concentrations, Estimated Environmental Doses, and Hazard Quotients: No Action Alternative

Constituent	No Action Lake, North Lobe - 5 Years			No Action Lake, South Lobe - 5 Years		
	Acute[1] Cw (mg/L)	Bald Eagle Acute EED (mg/kg-d)	Bald Eagle Acute HQ (unitless)	Acute[1] Cw (mg/L)	Bald Eagle Acute EED (mg/kg-d)	Bald Eagle Acute HQ (unitless)
Aluminum	1.00090	0.03420	0.00013	0.13311	0.00455	0.00002
Antimony	1.17766	0.04024	0.00035	0.09567	0.00327	0.00000
Arsenic (V)	0.32257	0.01102	0.00003	0.19233	0.00657	0.00002
Cadmium	0.00104	0.00000	0.00000	0.00338	0.00012	0.00000
Chromium	0.00076	0.00003	0.00000	0.00073	0.00003	0.00000
Copper	0.00157	0.00005	0.00000	0.01415	0.00048	0.00000
Fluoride	1.39567	0.04769	0.00095	0.94737	0.03237	0.00065
Lead	0.00014	0.00000	0.00000	0.00307	0.00011	0.00000
Manganese	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Mercury (Inorganic)	0.00023	0.00000	0.00000	0.00054	0.00002	0.00000
Methylmercury	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Nickel	0.08121	0.00277	0.00000	0.02891	0.00000	0.00001
Selenium (VI)	0.08112	0.00277	0.00277	0.01306	0.00045	0.00045
Silver	0.00080	0.00016	0.00000	0.00556	0.00019	0.00000
Thallium	0.04357	0.00149	0.00000	0.00872	0.00030	0.00001
Zinc	0.11723	0.00401	0.00000	0.03707	0.00127	0.00000

[1]Acute concentrations are based on the 95th percentile of the predicted concentrations of the north pit lake 5 years after closure.
Cw = Water concentration
EED = Expected environmental dose
HQ = Hazard quotient

TABLE C2-3 (continued)
Water Concentrations, Estimated Environmental Doses, and
Hazard Quotients: No Action Alternative

Constituent	No Action Lake - 27 Years			No Action Lake - 127 Years		
	Acute[1] Cw (mg/L)	Bald Eagle Acute EED (mg/kg-d)	Bald Eagle Acute HQ (unitless)	Acute[1] Cw (mg/L)	Bald Eagle Acute EED (mg/kg-d)	Bald Eagle Acute HQ (unitless)
Aluminum	0.52989	0.01811	0.00007	0.51668	0.01765	0.00007
Antimony	0.52379	0.01790	0.00016	0.93726	0.03202	0.00028
Arsenic (V)	0.24408	0.00834	0.00003	0.44052	0.01505	0.00005
Cadmium	0.00135	0.00006	0.00000	0.00203	0.00007	0.00000
Chromium	0.00074	0.00003	0.00000	0.00072	0.00002	0.00000
Copper	0.00176	0.00006	0.00000	0.00138	0.00005	0.00000
Fluoride	1.08785	0.03717	0.00074	1.56429	0.05345	0.00107
Lead	0.00013	0.00000	0.00000	0.00029	0.00001	0.00000
Manganese	0.00000	0.00006	0.00000	0.00000	0.00000	0.00000
Mercury (Inorganic)	0.00024	0.00001	0.00000	0.00029	0.00001	0.00000
Methylmercury	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Nickel	0.04964	0.00170	0.00003	0.05337	0.00182	0.00003
Selenium (VI)	0.03711	0.00127	0.00127	0.03574	0.00122	0.00122
Silver	0.00389	0.00013	0.00000	0.00508	0.00017	0.00000
Thallium	0.02043	0.00070	0.00002	0.03565	0.00122	0.00000
Zinc	0.06353	0.00217	0.00000	0.04257	0.00145	0.00000

[1]Acute concentrations are based on 95th percentile of the predicted concentrations of the north pit lake 5 years after closure.
Cw = Water concentration
EED = Expected environmental dose
HQ = Hazard quotient

TABLE C2-4
Water Concentrations, Estimated Environmental Doses, and Hazard Quotients: Proposed Action

Constituent	Proposed Action Lake, North Lobe - 5 Years			Proposed Action Pit Lake, South Lobe - 5 Years			Proposed Action Pit Lake, North Lobe - 27 Years		
	Acute[1] Cw (mg/L)	Acute EED (mg/kg-d)	Acute HQ (unitless)	Acute[1] Cw (mg/L)	Acute EED (mg/kg-d)	Acute HQ (unitless)	Acute[1] Cw (mg/L)	Acute EED (mg/kg-d)	Acute HQ (unitless)
Aluminum	1.038983	0.035501	0.000136	0.037750	0.001290	0.000005	0.703877	0.024050	0.000052
Antimony	1.178191	0.040257	0.000350	0.088691	0.003030	0.000026	1.296712	0.044307	0.000385
Arsenic (V)	0.315670	0.010786	0.000033	0.246284	0.008415	0.000026	0.479594	0.016387	0.000051
Cadmium	0.001249	0.000043	0.000000	0.002546	0.000087	0.000000	0.001089	0.000037	0.000000
Chromium	0.000767	0.000026	0.000002	0.000731	0.000025	0.000002	0.000752	0.000026	0.000002
Copper	0.001604	0.000055	0.000000	0.008726	0.000298	0.000001	0.000871	0.000030	0.000000
Fluoride	1.521330	0.051982	0.001040	0.843179	0.028810	0.000576	1.175520	0.040166	0.000803
Lead	0.000108	0.000004	0.000000	0.001662	0.000057	0.000000	0.000088	0.000003	0.000000
Manganese	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Mercury (Inorganic)	0.000269	0.000009	0.000000	0.000568	0.000019	0.000001	0.000190	0.000007	0.000000
Methylmercury	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Nickel	0.094235	0.003220	0.000049	0.016341	0.000558	0.000008	0.053382	0.001824	0.000028
Selenium (VI)	0.093396	0.003191	0.003191	0.005604	0.000191	0.000191	0.047110	0.001610	0.001610
Silver	0.005971	0.000204	0.000000	0.003476	0.000119	0.000000	0.004233	0.000145	0.000000
Thallium	0.046593	0.001592	0.000050	0.006151	0.000210	0.000007	0.048389	0.001653	0.000052
Zinc	0.113280	0.003871	0.000002	0.017951	0.000613	0.000000	0.031708	0.001083	0.000000

[1]Acute concentrations are based on the 95th percentile of the predicted concentrations of the north pit lake 5 years after closure.
Cw = Water concentration
EED = Expected environmental dose
HQ = Hazard quotient

TABLE C2-4 (continued)
Water Concentrations, Estimated Environmental Doses, and Hazard Quotients: Proposed Action

Constituent	Proposed Action Pit Lake, South Lobe 27 Years			Proposed Action Pit Lake 230 Years		
	Acute[1] Cw (mg/L)	Acute EED (mg/kg-d)	Acute HQ (unitless)	Acute[1] Cw (mg/L)	Acute EED (mg/kg-d)	Acute HQ (unitless)
Aluminum	0.051505	0.001760	0.000007	0.249498	0.008525	0.000033
Antimony	0.082081	0.002805	0.000024	0.800305	0.027345	0.000238
Arsenic (V)	0.241259	0.008243	0.000026	0.525670	0.017961	0.000056
Cadmium	0.002103	0.000072	0.000000	0.002274	0.000078	0.000000
Chromium	0.000734	0.000025	0.000002	0.000720	0.000025	0.000002
Copper	0.005332	0.000182	0.000001	0.001349	0.000046	0.000000
Fluoride	0.843925	0.028836	0.000577	1.555026	0.053133	0.001063
Lead	0.000515	0.000018	0.000000	0.000222	0.000008	0.000000
Manganese	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Mercury (Inorganic)	0.000461	0.000016	0.000001	0.000360	0.000012	0.000000
Methylmercury	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Nickel	0.015440	0.000528	0.000008	0.036668	0.001253	0.000019
Selenium (VI)	0.005227	0.000179	0.000179	0.017202	0.000588	0.000588
Silver	0.002952	0.000101	0.000000	0.004663	0.000159	0.000000
Thallium	0.004999	0.000171	0.000005	0.029971	0.001024	0.000032
Zinc	0.020864	0.000713	0.000000	0.025807	0.000882	0.000000

[1]Acute concentrations are based on 95th percentile of the predicted concentrations of the north pit lake 5 years after closure.
Cw = Water concentration
EED = Expected environmental dose
HQ = Hazard quotient

Attachment 3 - Additivity in Ecological Risk Assessment

This section provides a technical position on when to assume additivity in evaluating the toxicity of metals. The position assumes additivity in particular circumstances and sets forth the scientific rationale for this position assumption.

Additivity refers to the concept of whether one assumes that the toxicity of multiple chemicals in a mixture should be added to reflect their collective toxicity. The concept has been discussed extensively by Alabaster and Lloyd (1980) and adopted in Europe for regulating the acute toxicity of chemical mixtures in wastewaters. Additivity in acute toxicity is better understood than additivity in chronic toxicity, and assumptions about additivity may not hold for both acute and chronic toxicity. These differences are believed to reflect changes in the chemicals' mechanisms of action.

It is known that the toxicity of a chemical mixture may reflect the contributions of the constituents under certain circumstances. To account for this, the toxicities of chemicals with hazard quotients greater than 0.3 are added, *provided* (1) at least one chemical hazard quotient exceeds 1.0 and (2) the latter's mechanism of toxic action is similar to that of chemicals with hazard quotients greater than 0.3. For example, if the hazard quotient for copper exceeds 1.0, then the hazard quotients greater than or equal to 0.3 for metals with modes of toxic action similar to copper can be added to the copper hazard quotient. Suppose the hazard quotient for copper is 1.7 and the hazard quotients for cadmium, nickel, and zinc are 0.3, 0.5, and 0.7, the aggregate hazard quotient for these four divalent heavy metals is 3.2. The basis for these assumptions is explained further below.

Hazard Quotient Greater Than 1.0 Assumption

There are two reasons for requiring at least one chemical in a mixture to possess an hazard quotient exceeding 1.0 before considering additivity from other chemicals. First, it indicates that the toxicities of the chemicals in a mixture (effluent) must exceed a minimum risk threshold (i.e., hazard quotient greater than 1.0) before considering the risks posed by other chemicals. Secondly, the policy avoids situations where one could measure many chemicals in a mixture, whether 30 or 100, and assume the mixture is toxic because the chemical hazard quotients sum to greater than 1.0 even though each hazard quotient may be very low (e.g., 0.002, 0.2). In such a situation, it would be conceivable to declare that a sample has significant risks simply by measuring many chemicals. As indicated below, there is evidence that no more than three or four chemicals in a mixture contribute at any time to toxicity (Eaton 1973; Sprague 1970; Marking and Dawson 1975; Marking 1977). This is because the concentrations and toxicity of each chemical in a mixture typically are quite different. For example, in chronic toxicity tests of different proportions of cadmium, copper and zinc in a mixture to the fathead minnow, Eaton (1973) concluded that the mixture's toxicity was "*little if any more toxic than its zinc component alone*." Spehar et al. (1978) reached the same conclusion in a chronic toxicity test of flagfish (*Jordanella floridae*) exposed to mixtures of cadmium and zinc.

Hazard Quotient Greater Than 0.3 Assumption

The basis for summing only those chemicals with hazard quotients greater than 0.3 follows the recommendations of Cardwell et al. (1993) and Parkhurst et al. (1995), and is based on Parametrix (1993). There are two reasons for the hazard quotient greater than 0.3 criterion. First, chemicals with low hazard quotients (e.g., 0.5) actually pose very low risks when one considers the probabilities of exposure and adverse biological effect, which are computed by multiplying the probabilities. For example, when the hazard quotient is low, it reflects low probabilities (e.g., 3 percent) of exposure and/or adverse effects (Parametrix 1993). The second reason concerns the phenomenon discussed above whereby the toxicity of only a few chemicals in the mixture are expected to predominate at any one time (Eaton 1973; Könemann 1980; Spehar et al. 1978).

Requirement for Similar Mechanism of Action for Chemicals with Hazard Quotients Greater Than 0.3

Chemicals must have the same mode of action in order to assume their toxicities and risks are additive. In addition, this criterion is applied only when (1) the hazard quotient of at least one

chemical in the mixture is greater than or equal to 1.0 and (2) other chemicals with hazard quotients greater than 0.3 have the same mode of action as that of the chemical whose hazard quotient exceeds 1.0. This mode of action assumption is based on the scientific literature (e.g., Alabaster and Lloyd 1980; Könemann 1980) and has official agency sanction. For example, U.S. EPA's (1994a) draft guidance for conducting ecological risk assessments states *"if contaminants of ecological concern exist at the site, it may be appropriate to sum the hazard quotients for contaminants with the same ecological effect endpoint and/or the same mechanism of toxic effect."*

There is conflicting evidence in the literature as to which metals may have additive effects. Because the toxicity of metals and other inorganic chemicals may vary, depending on the chemical and species of organism considered (Alabaster and Lloyd 1980; Könemann 1980; Newman 1995; Spehar and Fiandt 1985), additivity is assumed only when supported by literature citations documenting similar modes of action or additivity. For example, Spehar and Fiandt (1985) learned that one cannot make broad generalizations concerning metal toxicity. They observed additivity in acute and chronic tests of arsenic, cadmium, chromium, copper, lead and inorganic mercury using freshwater invertebrates, and daphnids (*Ceriodaphnia dubia*), but observed some synergism in acute tests and antagonism in chronic tests of the same metals using a freshwater fish, the fathead minnow (*Pimephales promelas*). In general, there appears to be a consensus that, in theory, one can assume that the aquatic toxicity of divalent heavy metals is additive (Di Toro et al. 1991; USEPA 1994b); but as indicated above, there are exceptions to this generalization.

APPENDIX D

Human Health Risk Assessment

Appendix D Human Health Risk Assessment

A risk assessment was conducted to evaluate potential human health risks associated with the Twin Creeks Mine pit lake. The chemicals that could pose a potential risk to humans were identified in a screening-level risk assessment and subsequently evaluated in a baseline risk assessment for the Twin Creeks Mine.

D.1 Screening-Level Risk Assessment

The pit lakes associated with the No Action alternative and Proposed Action were evaluated in the human health risk assessment. The human health evaluation process paralleled the ecological risk assessment. Problem formulation, or development of the conceptual site model, is discussed in the ecological risk assessment (see Appendix C). Chemicals of primary concern included in the screening-level ecological risk assessment were also considered in the screening-level human health assessment. These chemicals are listed in Section C.1.1.2 in Appendix C. In contrast to the ecological risk assessment, the human health measurement endpoints were identified as the protection of individuals, rather than the population at potential risk.

The human health risk assessment used a method for evaluating potential risks similar to the method used for the ecological risk assessment. Hazard quotients, or the ratio of the estimated exposure dose or intake to a known dose below which adverse effects would not be expected, were calculated for each chemical and exposure pathway. If the hazard quotient was less than 1.0, the potential for adverse effects was considered negligible, and there was no need to evaluate the chemical further in the baseline risk assessment.

D.1.1 Exposure Assessment

Potential receptors and exposure pathways were identified for evaluation, and the media-specific dose or intake was quantified. Receptors are not likely to be exposed to the pit lake at 5 years post-closure for the No Action alternative or the Proposed Action because of the distance from the pit rim to the lake; therefore, risks were not quantified for the 5-year scenario. The only reasonable potential receptor for all of the other postclosure scenarios was assumed to be an adventurous hiker who visits the lake for a single weekend in a single year. The hiker is assumed to swim in the lake and, at the 127/230 year postclosure scenario, catch and consume fish from the lake. The potential exposure pathways evaluated in the human health screening-level risk assessment are shown in ***Table D-1***.

Media-specific intake of chemicals through incidental ingestion of surface water, dermal contact with surface water, and ingestion of fish were calculated as the mass of the chemical ingested or absorbed, divided by the mass of the receptor. Intake of fish and water, and dermal absorption were calculated following standard risk assessment guidelines (U.S. Environmental Protection Agency 1989). It was assumed in the screening-level risk assessment that the receptor would ingest 250 grams of fish caught from the lake; swim for 2.6 hours; and while swimming, 19,400 square centimeters of skin (the whole body) would be exposed to the surface water. An average adult body weight of 75 kilograms was assumed in the calculations.

Dermal absorption of chemicals during swimming was estimated using chemical-specific skin permeability values published in U.S. Environmental Protection Agency Dermal Guidance (U.S. Environmental Protection Agency 1992) and shown in ***Table D-2***.

Expected environmental concentrations in the lake at 27, 127, and 230 years postclosure

TABLE D-1
Potential Exposure Pathways

Alternative	5 Years	27 Years	Equilibrium
No Action Alternative	No receptors due to the distance to the lake.	Dermal contact with water while swimming. Incidental ingestion of water while swimming.	Dermal contact with water while swimming. Incidental ingestion of water while swimming. Ingestion of fish.
Proposed Action	No receptors due to the distance to the lake.	No receptors due to the distance to the lake.	Dermal contact with water while swimming. Incidental ingestion of water while swimming. Ingestion of fish.

TABLE D-2
Summary of Chemical-Specific Parameters Used in the Human Health Risk Assessment

Constituent	Fish Bioconcentration Factor (liters/kilogram)	Dermal Kp[1] (unitless)	10-Day Health Advisory (milligrams/kilogram-day)
aluminum	62.6	0.001	6.5×10^{-1}
antimony	0.5	0.001	1.0×10^{-2}
arsenic	1.0	0.001	1.0×10^{-2}
cadmium	24.0	0.001	4.0×10^{-3}
chromium	1.0	0.001	1.0×10^{-1}
copper	1.0	0.001	1.3×10^{-1}
fluoride	2.3	0.001	6.5×10^{-1}
lead	24.0	0.000004	6.4×10^{-2}
manganese	1800	0.001	1.0×10^{-1}
mercury	2,998	0.001	1.0×10^{-2}
nickel	0.8	0.0001	1.0×10^{-1}
selenium	30.5	0.001	4.1×10^{-3}
silver	14.5	0.0006	2.0×10^{-2}
thallium	65.7	0.001	7.0×10^{-4}
zinc	397.1	0.0006	6.0×10^{-1}

[1] Kp-Dermal Partition Coefficient
Source: Parametrix 1996

were estimated using the modeled around water results presented in Section 3.2 of the environmental impact statement. Fish tissue concentrations were estimated by multiplying chemical-specific bioconcentration factors by the modeled surface water concentrations. The fish tissue bioconcentration factors used in the risk assessment are shown in *Table D-2*.

D.1.2 Toxicity Assessment

The toxicity assessment is the equivalent of the ecological effects characterization in the ecological risk assessment. Toxicological properties of each chemical were evaluated, and appropriate toxicity values for comparison with the estimated exposure dose were selected. Because the pit lake is not intended

for recreational purposes, only acute, noncarcinogenic exposures were evaluated.

The measurement endpoint selected for the human health toxicity assessment is the 10-day Health Advisory (U.S. Environmental Protection Agency 1989, 1995). The 10-day Health Advisory represents the chemical concentration in drinking water that is not expected to cause adverse noncarcinogenic effects for up to 14 days of exposure to a child. Health Advisories were selected as a conservative estimate of a safe exposure level for acute adult exposures.

Health advisories are calculated by selecting an appropriate no-observed-adverse-effect level or lowest-observed-adverse-effect level, applying safety factors if necessary, and adjusting to a water concentration that is protective of a child. In order to compare the 10-day Health Advisory to the acute intake value (milligrams/kilogram per day) calculated in the exposure assessment, it was necessary to convert the water concentration Health Advisory back to the equivalent dose by dividing by the body weight of a child (10 kilograms) and multiplying by the child's assumed ingestion rate of water (1 liter/day) (U.S. Environmental Protection Agency 1990).

Safety factors that had been used in calculating the Health Advisory were not modified, with one exception. The U.S. Environmental Protection Agency incorporated a safety factor of 1,000 for protecting of sensitive individuals in the derivation of the antimony Health Advisory. A safety factor of 100 was considered more appropriate for use in this risk assessment, because it was assumed that only healthy, strong individuals would climb down to the pit lake and be exposed to chemicals.

Published 10-day Health Advisories were available for antimony, cadmium, chromium, nickel, silver, thallium, and zinc. For manganese and selenium, the Health Advisories were taken from their respective U.S. Environmental Protection Agency drinking water criteria documents. A 1-day Health Advisory was used for copper, because no 10-day Health Advisory was available. Health Advisories were derived for aluminum, arsenic, fluoride, lead, and mercury using relevant acute studies from the scientific literature, appropriate safety factors, and standard U.S. Environmental Protection Agency procedures. The 10-day Health Advisories used in the human health risk assessment are shown in ***Table D-2***.

D.1.3 Human Health Risk Characterization

Hazard quotients, or the ratio of the estimated acute intake or dose from the exposure assessment to the acute dose derived from the 10-day Health Advisory, were calculated for each chemical and each exposure pathway. The hazard quotients were summed across pathways to give a total hazard quotient for the receptor for each chemical. A hazard quotient less than 1.0 indicated that acute health effects were not likely to occur as a result of exposure to chemicals in the pit lake. Chemicals with a hazard quotient less than 1.0 ere not identified as chemicals of primary concern and were eliminated from further evaluation in the baseline risk assessment. A hazard quotient greater than 1.0 implied that the potential exists for human health effects to occur. Those chemicals with total hazard quotients greater than 1.0 were selected as chemicals of primary concern for further evaluation in the baseline risk assessment.

The hazard quotients for the No Action alternative at the 27-year postclosure scenario were all less than 1.0, indicating that potential health impacts would not be likely to occur based on the exposure assumptions and water concentrations for that scenario. The total hazard quotient for thallium for both the No Action alternative 127-year post-closure scenario and the Proposed Action 230-year postclosure scenario was 11.3 and 9.5, respectively. Therefore, thallium was identified as a chemical of potential concern to humans if they were to consume fish from the pit lake.

Thallium and its compounds have not been well studied. Little information is available on absorption, distribution, and metabolism. Animal studies suggest that thallium is completely absorbed and transported in the body in a manner similar to iron. Animal

studies also indicate thallium accumulates in the kidney, heart, brain, bone, skin, and blood.

Occupational exposure to thallium has been reported to affect the nervous system. Workers have complained of crawling of the skin, prickling skin, numbness of the extremities, burning feet, and muscle cramps (Agency for Toxic Substances and Disease Registry 1990). No data are available on the carcinogenic response associated with thallium in animals or humans (U.S. Environmental Protection Agency 1996).

D.1.4 Uncertainty Analysis

There are several possible sources of uncertainty in the human health risk assessment. These include the modeled pit lake water chemical concentrations, the fish bioconcentration factors, the exposure assumptions made in the dose equations, and the use of the 10-day Health Advisories as the toxicological benchmark values. The range of uncertainty in these values is discussed below, and the specific sources of uncertainty for thallium are presented in ***Table D-3***.

As the concentrations of chemicals in the pit lake were predicted from an empirical model (PTI 1996a), there is some uncertainty associated with the estimated water concentrations. For example, in the model, future concentrations of metals in ground water were estimated based on current ground water concentrations and predictions of the future ground water flow characteristics. However, in cases when a metal was not detected in the ground water under present conditions, it was assumed to be present at one-half of its laboratory detection limit. This practice may cause an overestimate of the predicted water concentration in the pit lake and subsequently may cause an overestimate of the risks to human health.

The concentrations of metals in fish tissue also are a source of uncertainty, as a bioconcentration factor is applied to the predicted water concentration. For most metals, the range of fish bioconcentration factors spans less than one order of magnitude. Other sources of uncertainty in the human health risk assessment include the exposure assumptions used in estimating the dose of water and fish that a person would consume from the pit lake. As the range of fish consumption rates or any other exposure parameter might span an order of magnitude, the uncertainty in the resulting estimate may also range up to an order of magnitude.

Use of the 10-day Health Advisories for children as a benchmark dose for protecting adults against acute effects is another source of uncertainty. The population likely to be exposed to the pit lake would be comprised of healthy, adventurous people who are assumed to be capable of a rigorous climb into and out of the pit lake. This targeted population is quite different than the sensitive population (e.g., children and the elderly) targeted for the 10-day Health Advisories. Therefore, the risks predicted using these values as the benchmark dose may overpredict the actual risks to the exposed population.

TABLE D-3
Sources of Uncertainty in the Human Health Risk Assessment of Thallium

Sources of Uncertainty	Effect of Uncertainty
Fish bioconcentration factor	Over- or underestimate of risk
Use of 10-day Drinking Water Health Advisory	Overestimate of risk
Assumed 100 percent bioavailability of chemicals	Overestimate of risk

D.2 Baseline Risk Assessment

The baseline risk assessment made several refinements in the risk evaluation in order to produce a more realistic estimate of the potential risk to humans consuming fish from the pit lake.

The surface water concentration for thallium used in the screening-level risk assessment was refined in the baseline risk assessment, resulting in a 3.8 to 6.3 factor reduction in the exposure point concentration. The value used in the screening-level risk assessment was based on a conservative interpretation of below-detection-limit data in the ground water, resulting in an overestimation of the potential thallium concentration in pit lake water. Ground water data from 22 wells were used in the screening-level risk assessment. Three of four samples analyzed from a single well (M/O 394318-1) exhibited elevated thallium detection limits when compared with a sample analyzed by a more sensitive analytical technique. Because of the higher detection limits in these three samples, the average ground water concentration of thallium used in the screening level risk assessment to predict the future lake concentration was probably artificially inflated.

For the baseline risk assessment, the water quality simulation model was rerun using one-half the detection limit to replace the three elevated values used in the screening-level risk assessment. One-half the detection limit was determined to be a more appropriate representation of the actual value based on (1) the previous analysis using the more sensitive measurement technique, (2) an evaporative concentration experiment performed by PTI, and (3) the time invariant results for detected analytes from Well M/O 394318-1 (PTI 1996a). Using one-half the detection limit resulted in a reduction in the predicted thallium concentration in pit lake water by a factor of approximately 4 from the screening-level risk assessment estimates. In addition to revisions of the exposure point concentration, the toxicity value used in the screening-level risk assessment was reviewed and modified. The drinking water advisory developed by the U.S. Environmental Protection Agency's Office of Water was used in the screening-level risk assessment to screen the future pit lake concentration for evaluation of adverse effects to humans. The drinking water advisory is a nonregulatory concentration for protecting human health via drinking water. The U.S. Environmental Protection Agency has developed a draft subchronic oral reference dose for thallium based on the same no-observed-adverse-effects level used to derive the drinking water health advisory. The reference dose does not, however, include the additional safety factor for protecting sensitive members of the population that is included in the derivation of the drinking water advisory value. In addition, the baseline risk assessment modified the U.S. Environmental Protection Agency draft subchronic reference dose using standard procedures to account for differences in derivation of acute versus subchronic values. This resulted in a toxicity threshold value that is 10 percent of the rat no-observed-adverse-effects level. The value is considered to be protective because it falls two orders of magnitude below the range of exposure levels associated with sever acute effects to humans (Parametrix 1996).

As a result of these modifications, no human health risks from exposure to thallium by fish ingestion were identified in the baseline risk assessment. All of the estimated hazard quotients for human exposure to all chemical concentrations in the pit lake were less than 1.0. Therefore, no significant impacts to humans are anticipated from exposure to chemicals in the Twin Creeks Mine No Action alternative and Proposed Action pit lakes.

APPENDIX E

National Register of Historic Places Status of Cultural Resources Within the Project Area

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. ARS 762					
26Hu0514	lithic scatter/base camp		E(D)	---	---
26Hu2860	residential base camp		E(D)	---	---
26Hu3206	residential base camp/ranch	No Action Alternative	E(D)	Yes	None
26Hu3207	lithic scatter		NEL	---	---
26Hu3208	lithic scatter		NEL	---	---
26Hu3209	lithic scatter		NEL	---	---
26Hu3210	lithic scatter/trash scatter		NEL	---	---
26Hu3211	lithic scatter/field camp		E(D)	---	---
26Hu3212	lithic scatter/trash scatter		Pre-E(D), Hist-UK	---	---
26Hu3213	lithic scatter		NEL	---	---
26Hu3214	lithic scatter		NEL	---	---
26Hu3215	lithic scatter		NEL	---	---
26Hu3216	lithic scatter		NEL	---	---
26Hu3217	trash scatter		UK	---	---
26Hu3218	trash scatter		UK	---	---
26Hu3219	lithic scatter		NEL	---	---
26Hu3220	field camp and lithic scatter/trash scatter		Pre-E(D), Hist-NEL	---	---
26Hu3221	lithic scatter/field camp		E(D)	---	---
26Hu3222	lithic scatter		NEL	---	---
26Hu3223	lithic scatter		NEL	---	---
26Hu3224	lithic scatter/tool concentration		NEL	---	---
26Hu3225	lithic scatter		NEL	---	---
26Hu3226	historic rock cairn		UK	---	---
26Hu3227	lithic scatter		NEL	---	---
26Hu3228	lithic scatter		NEL	---	---
26Hu3229	lithic scatter		NEL	---	---
26Hu3230	lithic scatter		NEL	---	---
26Hu3231	residential base camp	Rabbit Creek Diversion	E(D)	Yes	Yes
26Hu3232	lithic scatter		NEL	---	---
26Hu3233	lithic scatter		NEL	---	---
26Hu3234	lithic scatter		NEL	---	---
26Hu3235	lithic scatter		NEL	---	---
26Hu3236	lithic scatter		E(D)	---	---
26Hu3237	lithic scatter		NEL	---	---
26Hu3238	lithic prospect/scatter		NEL	---	---
26HU3239	lithic scatter		NEL	---	---
26HU3240	lithic scatter		E(D)	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
26HU3241	lithic scatter		NEL	---	---
26HU3242	lithic scatter		NEL	---	---
26Hu3243	residential base camp		E(D)	---	---
26Hu3244	lithic scatter		NEL	---	---
26Hu3245	lithic scatter		E(D)	---	---
26Hu3246	lithic scatter		E(D)	---	---
26Hu3247	lithic scatter/field camp		E(D)	---	---
26Hu3248	lithic scatter		NEL	---	---
26Hu3249	lithic scatter/field camp		E(D)	---	---
26Hu3250	lithic scatter		NEL	---	---
26Hu3251	lithic scatter		NEL	---	---
26Hu3252	lithic scatter		NEL	---	---
26Hu3253	lithic scatter		NEL	---	---
26Hu3254	lithic scatter		NEL	---	---
26Hu3255	lithic scatter		NEL	---	---
26Hu3256	lithic scatter/field camp		E(D)	---	---
26Hu3257	residential base camp		E(D)	---	---
26Hu3258	residential base camp		E(D)	---	---
26Hu3259	residential base camp		E(D)	---	---
26Hu3260	lithic scatter		NEL	---	---
26Hu3261	lithic scatter/trash scatter		Pre-E(D), Hist-NEL	---	---
26Hu3262	lithic scatter		NEL	---	---
26Hu3263	lithic scatter		NEL	---	---
26Hu3264	lithic scatter		E(D)	---	---
26Hu3265	historic irrigation system		UN	---	---
26Hu3266	ranch complex		E(C,D)	---	---
Report No. CR2-0015(P)					
CrNV-21-0103	lithic scatter		NEL	---	---
CrNV-21-0104	lithic scatter		NEL	---	---
CrNV-21-0105	lithic scatter		NEL	---	---
Report No. CR2-0028(P)					
CrNV-02-0093	lithic scatter		UN	---	---
CrNV-02-0094	lithic scatter		UN	---	---
CrNV-02-0095	lithic scatter		UN	---	---
CrNV-02-0096	rock shelter/cave		UN	---	---
CrNV-02-0097	lithic scatter		UN	---	---
CrNV-02-0098	lithic scatter/tool concentration		UN	---	---
CrNV-02-0099	lithic scatter		UN	---	---
CrNV-02-0102	lithic scatter		UN	---	---
Report No. CR2-0045(P)					
CrNV-02-0100	rock shelter/petroglyph		UN	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. CR2-0070(P)					
CrNV-02-0761	lithic scatter		NEL	---	---
CrNV-02-0763	lithic scatter		NEL	---	---
CrNV-02-0820	lithic scatter		NEL	---	---
CrNV-21-0752	lithic scatter/historic bldg		NEL	---	---
CrNV-21-0753	lithic scatter/ranch complex		NEL	---	---
CrNV-21-0759	lithic scatter		NEL	---	---
CrNV-21-0765	lithic scatter		NEL	---	---
CrNV-21-0759	lithic scatter		NEL	---	---
CrNV-21-0757	lithic scatter		NEL	---	---
CrNV-21-0759	lithic scatter		NEL	---	---
CrNV-21-0760	lithic scatter		NEL	---	---
CrNV-21-0762	lithic scatter/base camp		E(D)	---	---
CrNV-21-0760	rock shelter		NEL	---	---
CrNV-21-0765	lithic scatter/camp site		NEL	---	---
CrNV-21-0757	lithic scatter		NEL	---	---
CrNV-21-0771	lithic scatter		NEL	---	---
Report No. CR2-0183(P)					
CrNV-02-0958	lithic scatter		NEL	---	---
Report No. CR2-0192(P)					
CrNV-02-1011	lithic scatter		NEL	---	---
CrNV-02-1012	lithic scatter/camp site		NEL	---	---
CrNV-02-1013	lithic scatter		NEL	---	---
Report No. CR2-0194(P)					
26Hu0855	lithic scatter		NEL	---	---
CrNV-02-1037	lithic scatter/camp site		NEL	---	---
Report No. CR2-0196(P)					
CrNV-02-1125	lithic scatter		NEL	---	---
Report No. CR2-0210(P)					
CrNV-21-3761	lithic scatter		NEL	---	---
Report No. CR2-0537(P)					
CrNV-02-2649	lithic scatter		NEL	---	---
Report No. CR2-0587(P)					
CrNV-02-2726	lithic scatter/camp site		NEL	---	---
Report No. CR2-0745(P)					
CrNV-02-2860	residential base camp		Pre-E(D), Hist-NEL	---	---
CrNV-02-2863	lithic scatter		NEL	---	---
CrNV-02-2864	lithic scatter		UN	---	---
CrNV-21-2861	lithic scatter		NEL	---	---
Report No. CR2-0760(P)					
CrNV-21-2898	lithic scatter		NEL	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. CR2-1031(P)					
CrNV-21-3339	rock wall		NEL	---	---
Report No. CR2-1063(P)					
CrNV-21-3386	lithic scatter/camp site	No Action Alternative	NEL	Yes	None
Report No. CR2-2004(P)					
CrNV-21-3544	lithic scatter		NEL	---	---
Report No. CR2-2025					
26Hu2581	lithic scatter		NEL	---	---
Report No. CR2-2039(P)					
CrNV-21-3622	lithic scatter		NEL	---	---
Report No. CR2-2092(P)					
CrNV-21-3684	lithic scatter and tool concentration/camp site		NEL	---	---
Report No. CR2-2098(P)					
CrNV-21-3725	lithic scatter		NEL	---	---
CrNV-21-3699	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3708	lithic scatter		NEL	---	---
CrNV-21-3685	lithic scatter		NEL	---	---
CrNV-21-3695	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3696	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3697	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3699	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3699	trash scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3700	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3700	lithic scatter	No Action Alternative	NEL	Yes	None
CrNV-21-3715	prospect		NEL	---	---
CrNV-21-3717	lithic scatter/camp site		NEL	---	---
CrNV-21-3722	prospect pit		NEL	---	---
CrNV-21-3733	lithic scatter		NEL	---	---
Report No. CR2-2108(P)					
CrNV-21-3761	lithic scatter	Overburden Storage	NEL	Yes	None
Report No. CR2-2111(P)					
CrNV-21-3767	lithic scatter		NEL	---	---
CrNV-21-3768	lithic scatter		NEL	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-3769	lithic and ceramic scatter		NEL	---	---
CrNV-21-3770	two (2) lithic isolates		NEL	---	---
CrNV-21-3771	two (2) lithic isolates		NEL	---	---
CrNV-21-3772	lithic scatter		NEL	---	---
CrNV-21-3773	lithic scatter		NEL	---	---
Report No. CR2-2176(P)					
CrNV-21-4007	lithic scatter		NEL	---	---
CrNV-21-4009	lithic scatter		NEL	---	---
CrNV-21-4010	lithic scatter		NEL	---	---
Report No. CR2-2204(P)					
CrNV-21-4120	lithic scatter		NEL	---	---
CrNV-21-4121	lithic scatter		NEL	---	---
CrNV-21-4122	lithic scatter/camp site		NEV	---	---
CrNV-21-4123	lithic scatter		NEL	---	---
CrNV-21-4124	ranch and industrial vestige		NEL	---	---
CrNV-21-4125	lithic scatter		NEL	---	---
Report No. CR2-2246(P)					
CrNV-21-4452	lithic scatter	Overburden Storage	NEL	Yes	None
CrNV-21-4453	lithic scatter	Overburden Storage	NEL	Yes	None
CrNV-21-4459	lithic scatter		NEL	---	---
CrNV-21-4460	lithic scatter		NEL	---	---
CrNV-21-4461	lithic scatter		NEL	---	---
Report No. CR2-2271(P)					
CrNV-21-4578	lithic scatter		NEL	---	---
Report No. CR2-2351(P)					
CrNV-21-4999	lithic scatter		NEL	---	---
CrNV-21-4999	lithic scatter		NEL	---	---
CrNV-21-5000	lithic scatter/camp site		E	---	---
Report No. CR2-2476(P)					
CrNV-21-5541	lithic scatter		NEL	---	---
Report No. CR2-2567(P)					
CrNV-02-0768	residential base camp/historic dam		Pre-E(D), Hist-UN	---	---
CrNV-21-2651	lithic scatter		E(D)	---	---
CrNV-02-2862	lithic scatter		E(D)	---	---
CrNV-21-5733	lithic scatter/trash scatter		Pre-E(D), Hist-NEL	---	---
CrNV-21-5734	lithic scatter		E(D)	---	---
CrNV-21-5736	lithic scatter		E(D)	---	---
CrNV-21-5736	lithic scatter		NEL	---	---
CrNV-21-5758	lithic scatter		NEL	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5763	lithic scatter		NEL	---	---
CrNV-21-5760	lithic scatter		NEL	---	---
CrNV-21-5768	lithic scatter		E(D)	---	---
CrNV-21-5768	lithic scatter		NEL	---	---
CrNV-21-5768	lithic scatter		NEL	---	---
CrNV-21-5768	lithic scatter		E(D)	---	---
CrNV-21-5768	lithic scatter		NEL	---	---
CrNV-21-5768	lithic scatter		NEL	---	---
CrNV-21-5768	lithic scatter		NEL	---	---
CrNV-21-5768	lithic prospect/scatter		E(D)	---	---
CrNV-21-5769	lithic scatter		E(D)	---	---
CrNV-21-5770	lithic scatter		NEL	---	---
CrNV-21-5771	lithic scatter		NEL	---	---
CrNV-21-5772	lithic scatter		NEL	---	---
CrNV-21-5779	lithic scatter		NEL	---	---
CrNV-21-5777	lithic scatter/field camp		E(D)	---	---
CrNV-21-5776	lithic scatter		NEL	---	---
CrNV-21-5776	lithic scatter		NEL	---	---
CrNV-21-5777	lithic scatter		NEL	---	---
CrNV-21-5779	lithic scatter		NEL	---	---
CrNV-21-5779	lithic scatter		NEL	---	---
CrNV-21-5783	lithic scatter		E(D)	---	---
CrNV-21-5781	lithic scatter		NEL	---	---
CrNV-21-5792	lithic prospect/quarry		NEL	---	---
CrNV-21-5783	lithic scatter		NEL	---	---
CrNV-21-5781	lithic scatter		NEL	---	---
CrNV-21-5796	lithic scatter		NEL	---	---
CrNV-21-5786	lithic scatter		E(D)	---	---
CrNV-21-5788	lithic prospect/scatter		NEL	---	---
CrNV-21-5788	lithic scatter		NEL	---	---
CrNV-21-5783	lithic scatter		NEL	---	---
CrNV-21-5790	lithic scatter/field camp		E(D)	---	---
CrNV-21-5791	lithic prospect/scatter		NEL	---	---
CrNV-21-5792	lithic prospect/scatter		NEL	---	---
CrNV-21-5793	lithic prospect/scatter		NEL	---	---
CrNV-21-5790	lithic scatter		E(D)	---	---
CrNV-21-5796	lithic scatter		NEL	---	---
CrNV-21-5796	lithic prospect/scatter		NEL	---	---
CrNV-21-5797	lithic scatter		NEL	---	---
CrNV-21-5796	lithic scatter		NEL	---	---
CrNV-21-5799	lithic scatter		NEL	---	---
CrNV-21-5800	lithic scatter		NEL	---	---
CrNV-21-5801	lithic scatter		NEL	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5802	lithic scatter		NEL	---	---
CrNV-21-5803	lithic scatter		NEL	---	---
CrNV-21-5807	lithic scatter		NEL	---	---
CrNV-21-5805	lithic scatter		NEL	---	---
CrNV-21-5806	lithic scatter		NEL	---	---
CrNV-21-5807	lithic scatter		NEL	---	---
CrNV-21-5806	lithic prospect/scatter		NEL	---	---
CrNV-21-5803	lithic scatter		NEL	---	---
CrNV-21-5814	hunting blind		NEL	---	---
CrNV-21-5814	lithic prospect/scatter		NEL	---	---
CrNV-21-5802	lithic scatter		NEL	---	---
CrNV-21-5813	lithic scatter/trash scatter		Pre-E(D), Hist-NEL	---	---
CrNV-21-5814	lithic scatter		NEL	---	---
CrNV-21-5815	lithic scatter		NEL	---	---
Report No. CR2-2568(P)					
CrNV-21-5859	lithic scatter	Tailings Impoundment	NEL	Yes	None
CrNV-21-5860	lithic scatter	Tailings Impoundment	NEL	Yes	None
CrNV-21-5861	lithic scatter/historic isolate		Pre-E(D), Hist-NEL	---	---
CrNV-21-5862	lithic scatter		NEL	---	---
CrNV-21-5863	lithic scatter		NEL	---	---
CrNV-21-5860	field camp/historic isolate		Pre-E(D), Hist-NEL	---	---
CrNV-21-5866	lithic scatter		NEL	---	---
CrNV-21-5866	lithic scatter/field camp		E(D)	---	---
CrNV-21-5867	lithic scatter/field camp		E(D)	---	---
CrNV-21-5866	lithic scatter/field camp		E(D)	---	---
CrNV-21-5866	lithic scatter		NEL	---	---
CrNV-21-5870	lithic scatter		NEL	---	---
CrNV-21-5871	lithic scatter		NEL	---	---
CrNV-21-5870	lithic scatter		NEL	---	---
CrNV-21-5873	lithic scatter		NEL	---	---
CrNV-21-5870	lithic scatter		NEL	---	---
CrNV-21-5875	lithic scatter		NEL	---	---
CrNV-21-5876	lithic scatter		NEL	---	---
CrNV-21-5877	lithic scatter/trash scatter		NEL	---	---
CrNV-21-5878	lithic scatter		NEL	---	---
CrNV-21-5879	lithic scatter/field camp		E(D)	---	---
CrNV-21-5880	lithic scatter		NEL	---	---
CrNV-21-5881	lithic scatter		NEL	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5882	lithic scatter		NEL	---	---
CrNV-21-5889	lithic scatter		NEL	---	---
CrNV-21-5894	historic artifact scatter		NEL	---	---
CrNV-21-5889	lithic scatter		E(D)	---	---
CrNV-21-5886	lithic scatter		NEL	---	---
CrNV-21-5887	lithic scatter		NEL	---	---
CrNV-21-5888	lithic scatter		NEL	---	---
CrNV-21-5889	lithic scatter		NEL	---	---
CrNV-21-5894	lithic scatter		NEL	---	---
CrNV-21-5894	lithic scatter		NEL	---	---
CrNV-21-5892	lithic scatter		NEL	---	---
CrNV-21-5889	lithic scatter		E(D)	---	---
CrNV-21-5894	lithic scatter/field camp		E(D)	---	---
CrNV-21-5895	lithic prospect/scatter		NEL	---	---
CrNV-21-5896	lithic scatter		NEL	---	---
CrNV-21-5894	lithic scatter		NEL	---	---
CrNV-21-5898	field camp/trash scatter		Pre-E(D), Hist-NEL	---	---
CrNV-21-5899	lithic scatter		NEL	---	---
CrNV-21-5900	lithic scatter		NEL	---	---
CrNV-21-5901	field camp/location		E(D)	---	---
CrNV-21-5903	lithic scatter		NEL	---	---
CrNV-21-5904	lithic scatter		NEL	---	---
CrNV-21-5904	lithic scatter		NEL	---	---
CrNV-21-5905	lithic scatter		E(D)	---	---
CrNV-21-5906	lithic scatter		NEL	---	---
CrNV-21-5907	lithic scatter		NEL	---	---
CrNV-21-5908	lithic scatter		NEL	---	---
CrNV-21-5909	residential base camp		E(D)	---	---
CrNV-21-5917	lithic scatter		NEL	---	---
CrNV-21-5911	lithic scatter		NEL	---	---
CrNV-21-5912	lithic scatter		E(D)	---	---
CrNV-21-5913	lithic scatter		NEL	---	---
CrNV-21-5917	lithic scatter		NEL	---	---
CrNV-21-5915	lithic scatter		NEL	---	---
CrNV-21-5916	lithic prospect/scatter		NEL	---	---
CrNV-21-5917	lithic scatter		NEL	---	---
CrNV-21-5918	lithic scatter		NEL	---	---
CrNV-21-5919	residential base camp/historic isolate		Pre-E(D), Hist-NEL	---	---
CrNV-21-5920	lithic scatter/field camp		E(D)	---	---
CrNV-21-5921	lithic scatter		NEL	---	---
CrNV-21-5922	hunting blind		NEL	---	---
CrNV-21-5923	lithic scatter		NEL	---	---
CrNV-21-5924	lithic scatter/field camp		E(D)	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5925	lithic scatter		NEL	---	---
FORM ONLY					
Ao-0122	lithic scatter		UN	---	---
CrNV-02-1124	quarry/lithic scatter		NEL	---	---
CrNV-21-0422	Getchel Mine Complex		UN	---	---
CrNV-21-5543	Shoshone Mike Massacre Site	No Action Alternative (Overburden Storage) Proposed Action (Far West Diversion)	E(A,B,D)	Yes	Yes

E = Eligible (State Historic Preservation Office concurrence)
NEV = Eligible pending further evaluation (State Historic Preservation Office concurrence)
NEL = Not eligible (State Historic Preservation Office concurrence)
UN = Unevaluated

APPENDIX F

Public Comments and Responses to the Draft EIS

DRAFT EIS PUBLIC COMMENTS

Letter Number	Respondent
1	U.S. Environmental Protection Agency
2	U.S. Fish and Wildlife Service
3	Nevada Department of Administration
4	Nevada State Clearinghouse
5	Nevada Department of Business and Industry, Division of Minerals
6	Nevada Natural Heritage Program
7	Nevada Department of Transportation, Carson City
8	Nevada Department of Transportation, Winnemucca
8a	Nevada Department of Transportation, Carson City
9	Nevada Department of Conservation and Natural Resources, Division of Water Resources
10	Nevada Department of Conservation and Natural Resources, Division of Wildlife
11	Sierra Club
12	Great Basin Mine Watch
13	Laser, Inc.
14	Shoshone Bannock Tribe
15	Western Shoshone Defense Project
16	Getchell Gold Corporation
17	Corbin Harney, Harvey and Charlotte Healey, and Jim Gelford
18	Sharon Sweeney
	Public Meeting Comments

Letter 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

August 29, 1996

Gerald Moritz
Bureau of Land Management
5100 E. Winnemucca Boulevard
Winnemucca, NV 89445

Dear Mr. Moritz:

The U.S. Environmental Protection Agency (EPA) has reviewed the **Draft Environmental Impact Statement (DEIS) for the Twin Creeks Mine, Humboldt County, Nevada.** Our review and comments are provided pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's NEPA Implementation Regulations at 40 CFR 1500-1508, and Clean Air Act Section 309.

The DEIS evaluates alternatives for mining Santa Fe Pacific Gold Corporation's Twin Creeks Mine in the eastern Osgood Mountains 35 miles northeast of Winnemucca, Nevada. The proposed project would join two existing pits into a larger pit, add 7 waste rock disposal areas, a tailings disposal area, two heap leach pads and other facilities disturbing an additional 5217 acres. The project will produce up to 15.8 million ounces of gold.

We have rated this DEIS as EO-2 -- Environmental Objections-Insufficient Information (see enclosed "Summary of Rating Definitions and Follow-Up Action"). Our objections are based on the proposed project's potential impacts to water quality and quantity and biological resources, including potentially significant impacts associated with groundwater drawdown from pit dewatering; as well as the project's potential risks related to geologic hazards and the design of several of the mine's facilities. We also believe that additional information is needed in the Final Environmental Impact Statement (FEIS) regarding impacts to water quality and quantity and biological resources, as well as geologic hazards, design improvements, mitigation measures, geochemical characterization, reclamation, and ecological risk assessment. Our specific comments are enclosed.

Letter 1 Continued

We appreciate the opportunity to review your DEIS. Our principal reviewer, Jeanne Geselbracht, will be in contact with your office to schedule a time to discuss the issues identified in our detailed comments. Meanwhile, should you have questions, please contact me at (415) 744-1015 or have your staff call Ms. Geselbracht at (415) 744-1576. One copy of the FEIS should be provided to this office at the same time it is filed with our Washington, D.C. Office.

Sincerely,

Deanna M. Wieman, Deputy Director
Cross-Media Division

Enclosures

cc: Doug Zimmerman, NDEP
Kevin Roukey, U.S. Army Corps of Engineers
John Miesner, U.S. Fish and Wildlife Service
Rory Lamp, NDOW

Letter 1 Continued

SUMMARY OF RATING DEFINITIONS AND FOLLOW-UP ACTION

Environmental Impact of the Action

LO-Lack of Objections

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC-Environmental Concerns

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

EO-Environmental Objections

The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU-Environmentally Unsatisfactory

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of environmental quality, public health or welfare. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommend for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1-Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2-Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3-Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From: EPA Manual 1640, "Policy and Procedures for the Review of Federal Actions Impacting the Environment."

Letter 1 Continued

Geologic Hazards

The DEIS presents information which EPA believes under-represents the potential structural failure associated with dewatering-induced ground fissures beneath the lined tailings impoundments, process ponds, and heap leach facilities. If these failures occur, an uncontrolled, undetectable release of contaminants to the environment or the failure of impoundment structures, resulting in injury to workers, may result.

The major area of concern is on the southern end of the South Pit. This area contains tailings impoundments, heap leach facilities, and the Piñon Mill. The DEIS predicts up to five feet of subsidence beneath the existing 'G' heap leach pad and close to two feet beneath tailings impoundments 'C' and 'E'. It goes on to state that the San Joaquin Valley in California has subsided up to 30 feet and has not resulted in ground breakage and that, based on the available information, it is not possible to determine if groundwater withdrawl could result in discontinuous subsidence (ground fissures).

1-1 In a south-central Arizona portion of the Basin and Range province, earth fissures developed within the unconsolidated sediments from overpumping. This area and the Twin Creeks site are distinctly different from the Central Valley. Investigations of the Arizona fissures (Troy Péwé, *Environmental Geology of Arizona* in Jenney and Reynolds, 1989: Geologic Evolution of Arizona) indicate that many, if not most, occur (1) in the alluvial basin near the fronts of mountains, (2) where the depth to bedrock is 200 to 1000 feet, and (3) where the alluvium is dewatered to a depth of 300 feet or more. Bedrock irregularities were also strongly correlated with fissures.

Since the mine is (1) close to the mountain front, (2) the entire thickness of the alluvium (700 feet) near the south pit will be dewatered, and (3) bedrock irregularities are present, fissures are a threat to the integrity of the facilities. A fissure through the liner of the heap leach facility or the tailings impoundment may not be detected because of the large size of the facility and the relatively short length of typical subsidence induced fissures. A detection system for fissures is essential for areas on the south side of the South pit.

1-2 Mitigation measure GM-2 (DEIS, pp. 3-27, 28) appears to be insufficient. The number and location of monitoring devices should not be determined by the site geotechnical engineer unless the engineer is a third party and has experience with subsidence-

Response to Letter 1

1-1 The risk and potential impacts from discontinuous subsidence or earth fissures were acknowledged in the Draft EIS. For example, on page 3-22 the Draft EIS states that "*Discontinuous subsidence could break the ground surface and potentially damage solution-bearing facilities. Any substantial discontinuous subsidence and ground breakage beneath process or solution facilities that could potentially damage the fluid containment would be considered a significant impact.*" A paragraph has been added to Section 3.1.2.1 of the Final EIS under the geologic hazards subheading that summarizes reported occurrences, causes, and environmental effects of earth fissures. To reduce possible confusion, the phrase "earth fissure" has been substituted for "discontinuous subsidence and ground breakage" where appropriate in the Final EIS. Earth fissures attributable to ground water withdrawal have occurred in several basins in south-central Arizona. However, earth fissures have not developed or are rare in numerous other basins in Arizona, Nevada, and California that have undergone substantial subsidence.

1-2 Mitigation measure GM-2 in the Final EIS has been revised to include additional details regarding subsidence and earth fissure monitoring in the vicinity of process facilities. As part of the EIS process, BLM technical specialists have evaluated the adequacy of the subsidence monitoring program. SFPG, in consultation with the BLM, would update and revise monitoring as necessary throughout the life of the project.

Letter 1 Continued

1-2 induced fissures. Pre-construction design changes appear necessary because, once the heap leach facility is built, repair or abandonment may be expensive propositions. Mitigation measure GM-2 involves designing facilities containing process solutions to prevent failure of the liner or drainage system from the combined effects of settlement and dewatering induced subsidence, but it does not include the need to withstand dewatering-induced fissures. A thicker soil or synthetic liner may help prevent
1-3 failure and should be incorporated as part of the mitigation. Embankments should be constructed higher and wider to help withstand a potential failure from a fissure. A proposal to raise embankments as settlement occurs is not adequate because fissures would most likely develop rapidly. The mitigation plan includes repairing or modifying the heap leach pile if a problem develops. It is unclear how this would be done to a liner beneath a heap leach pile that is 200 feet thick. The FEIS should include a more detailed discussion of the mitigation measures as well as the recommended design changes.

Tailings Impoundments

1-4 The description of the factor of safety for tailings area A is not clear. The DEIS (p. 3-21, 4th paragraph) discusses different scenarios without providing factor of safety information for each one. For example, the DEIS states that the embankment will remain 'stable' after experiencing liquefaction. The FEIS should define 'stable' in this context.

1-5 The tailings impoundment design has a factor of safety of only 1.1 to 1.3 during a 'moderate' earthquake. This factor of safety value seems rather low. The FEIS should define 'moderate' earthquake and indicate the factor of safety for the impoundments in a maximum probable earthquake event. The industry standard for factor of safety for such structures is 1.5.

1-6 The geotechnical analysis is not available for tailings impoundments C or E. These impoundments are in the area of potential subsidence and, therefore, potential fissures. As described below, the stability of tailings impoundment A is questionable even without the potential for differential settlement. Given the potential for differential settlement, as seen for impoundments C and E, and a questionable stability analysis, a geotechnical analysis is needed. We recommend that tailings impoundments C and E be designed with a factor of safety greater than that provided for tailings impoundment A in order to withstand fissures.

The DEIS (p. 3-17) discusses acceleration values commonly used at mining sites but does not state the values that will apply to the

Response to Letter 1

1-3 Under Nevada Administrative Code 445A.397, engineering design reports for all process components must be submitted to the Nevada Division of Environmental Protection for approval. The Nevada Division of Environmental Protection is responsible for determining if the design of the process components is sufficient to protect the waters of the state from being degraded and establishing monitoring to verify compliance. In addition, a plan describing the actions that must be initiated and the party that must initiate them as a result of possible failure in the fluid management system must be included in the operating plan submitted as part of the Nevada Division of Environmental Protection's Water Pollution Control Permit (Nevada Administrative Code 445A.398). In the unlikely event that a large earth fissure would cause the release of process solutions that could potentially degrade waters of the state, the Nevada Division of Environmental Protection would likely require that the process component be shut down and cleanup activities be immediately initiated as defined in Nevada Administrative Code 445A.441-2

1-4 The stability analysis for tailings area A under the No Action alternative (currently permitted) is presented in Knight Piésold, Inc. 1992 and is incorporated into the EIS by reference. With respect to questions regarding the meaning of "stable" in the sentence on page 3-21 of the Draft EIS that states, "Even if the tailings were saturated and experienced liquefaction, the slope stability analysis indicated that the embankment would remain stable (Knight Piésold, Inc. 1992)," an analysis was conducted to evaluate post-earthquake stability, defined as a loss of strength caused by partial liquefaction of the tailings. In the post-earthquake analysis, an estimated internal friction angle for the saturated portion of the tailings material was reduced to 17 degrees from the original range of 25 to 35 degrees. This remolded strength friction angle was based on field vane shear tests. The postearthquake stability analysis conducted for different cases resulted in factors of safety ranging from 1.2 to 1.7, which indicates that the embankment would remain stable even if some loss of strength occurred during a seismic event. For additional details regarding this stability analysis, please refer to Knight Piésold Inc. 1992. This design report was approved by the Dam Safety Branch of the Nevada State Engineer's Office.

1-5 For tailings area A, the design horizontal seismic coefficient used for the pseudostatic stability analyses was 0.13g (acceleration of gravity) (see Knight and Piésold Inc. 1992). This value was taken as two-thirds of the peak horizontal acceleration of 0.20g expected to occur as the result of a magnitude 6.5 seismic event. As presented on page 3-17 of the Draft EIS, these values correspond to the predicted peak ground

acceleration of 0.16 and 0.22g predicted for seismic events with the probability of 10 percent exceedance in a 50- and 100-year period, respectively. Critical facilities, such as tailings embankments, are commonly designed to withstand the largest probable event that could potentially occur during the operation and reclamation periods. Typically, this event is assumed to be the maximum probable event that would occur in a 50-year period (Lo and Klohn 1996).

To address the comment that a factor of safety of 1.5 is the industry standard for such structures, Jason King (Chief, Engineering and Dam Safety, State Engineer's Office; responsible for public safety with respect to dams in Nevada) was contacted. Mr. King indicated that for static analyses, a factor of safety of 1.5 is considered adequate; however, for pseudostatic analyses, a factor of safety of 1.0 or greater is acceptable. The design of the future tailings facilities would meet or exceed standards for static and pseudostatic factors of safety as approved by the Dam Safety Branch of the Nevada State Engineer's Office.

1-6 Mitigation measure GM-1 in the Draft EIS states that, "Stability analyses would be performed to demonstrate that all proposed tailings facilities would remain functional after the passage of an Operation Basis Earthquake, and would not fail catastrophically or release tailings or fluids during a Maximum Credible Earthquake." On page 3-17, the Draft EIS defines the operational basis event as the maximum probable event that would occur within a 50- or 100-year period. The peak ground acceleration for the maximum event for the project area is defined on page 3-18 of the Draft EIS. On the same page, it is stated that, "Critical facilities, such as tailings embankments, should be designed to prevent excessive deformation or collapse under this estimated maximum seismic loading." Estimated peak accelerations for probabilistic earthquakes used as the operations basis event and the maximum credible earthquake are based on the data presented in Siddharthan, et. al. 1993. In addition, mitigation measure GM-1 states, "The minimum factors of safety for all slope designs would be determined as part of the permits and approvals granted by the Nevada Division of Environmental Protection, Nevada Department of Water Resources, Dam Safety Division, and the BLM." The minimum factors of safety vary by facility and for static and pseudostatic analyses (see the response to comment 1-5). It is not necessary to specify design criteria in the EIS since state agencies are responsible for approving facility design, and each facility is evaluated on a case-by-case basis.

Letter 1 Continued

1-6 Twin Creeks site. Elsewhere, the DEIS (p. 3-25) states that a failure analysis for the impoundments to be constructed has not been conducted. This information should be provided in the FEIS, including the assumptions used. As is stated on page 3-25 of the DEIS, "improper design, construction, and facility closure could result in slope failure and damage to the underlying tailings containment structure and could cause significant geologic impacts." Failure of any facility and subsequent release to waters of the U.S. could also result in a violation of a National Pollutant Discharge Elimination System (NPDES) permit.

1-7 The FEIS should discuss in more detail the stability of the arsenic precipitate that is slurried into the Piñon tailings disposal area (DEIS, p. 2-9).

1-8 According to the DEIS (pp. 2-17 and 2-30), the tailings impoundments and solution pond facilities will be designed to contain a 24-hour, 25-year storm and withstand runoff from a 24-hour, 100- year storm. In EPA's inspection and compliance experience, we have found that facilities with 25-year storm retention capacity commonly have difficulties maintaining zero discharge capabilities. We recommend that BLM consider requiring more realistic zero-discharge containment capacities for 24-hour, 100-year storms. This appears to be especially relevant at tailings area B, which is located immediately adjacent to the Rabbit Creek diversion structure.

1-9 The DEIS (pp. 2-18 and 2-30) states that tailings area B may or may not be synthetically lined, depending on the chemistry of the tailings. The chemistry of the tailings must be known prior to construction of the tailings impoundment in order to determine the type of liner to be used. The factors to be used in determining tailings area destinations (e.g., tailings area A versus tailings area B), tailings chemistry, and liner specifications should be provided for each of the tailings areas in the FEIS. The FEIS should also discuss the geochemical characteristics that would determine a synthetic and a non-synthetic liner.

1-10 The reclamation of tailings area B will need to include effective reinforcement (e.g., riprap and infiltration prevention) along the slope that is adjacent to the Rabbit Creek diversion in order to ensure long-term post-closure integrity and prevent failure of the tailings area into Rabbit Creek.

Heap Leach Pad

The DEIS (pp. 2-18 and 2-32) states that the leach pads would be equipped with leak detection systems in areas of "high solution

Response to Letter 1

1-7 The ferric arsenate from the water treatment plant is mixed with the tailings from the mill process before it is discharged to the Piñon tailings impoundment. As summarized on page 3-82 of the Draft EIS, analysis of the precipitate using the U.S. Environmental Protection Agency's Toxicity Characteristic Leaching Procedure indicates the precipitate is not hazardous. The ferric arsenate, which accounts for less than 1 percent of the material in the tailings impoundment, should not influence the stability of the tailings impoundment. Sub-aerial deposition is used within the tailings impoundment to maximize tailings density by depositing the tailings in thin layers and rotating deposition areas to allow the thin layers of tailings to dry. The Nevada Division of Water Resources and the Nevada Division of Environmental Protection approved the design of the tailings impoundment as a stable facility prior to issuing Dam Safety Permit J-327 and Water Pollution Control Permit NEV 89035. The as-built construction report was approved by both agencies. Future impoundments would be designed and constructed to meet or exceed the requirements of both agencies.

1-8 The current approach uses design events that comply with Nevada Division of Environmental Protection requirements, which are presented in Nevada Administrative Code 445A.433. In addition, the proposed operation would undergo a number of environmental permitting reviews by the Nevada Division of Environmental Protection. If other design needs are identified during that process, SFPG and the State would evaluate their implementation.

1-9 Pages 2-18 and 2-30 of the Draft EIS state that synthetic liners would be considered in the design of future tailings areas B, C, and D. The Nevada Division of Environmental Protection requires a liner consisting of a minimum of 12 inches of recompacted native, imported, or amended soils that have an in-place recompacted coefficient of permeability of no more than 1 x 10-6 centimeters per second or competent bedrock or other geologic formations underlying the site that have been demonstrated to provide an equivalent degree of containment. Nevada Administrative Code 445A.437 lists other factors that would be considered by the Nevada Division of Environmental Protection prior to requiring an alternate level of containment. At a minimum, all facilities would be designed to meet

the requirements of Nevada Administrative Code 445A.437 and the Nevada Division of Environmental Protection guidelines. Additionally, synthetic liners may be placed in future impoundment areas where the supernatant pool is expected to contain the greatest depth of water for extended periods of time and/or beneath solution transfer pipe-work. Synthetic liners also may be placed beneath decant towers and clarification sumps. Geochemical characteristics of the tailings, including, but not limited to, the presence of cyanide and the potential to generate acid also will be factors in determining the liner system design for future impoundments. Future decisions regarding liner design would take into account these considerations and would be made after consulting with the Nevada Division of Environmental Protection.

1-10 Slope and drainage stability along the diversion and the project area drainages is addressed in mitigation measure WR-9 in Section 3.2.4 of the Final EIS. Riprap and other protective measures are identified in this section. In addition, as shown in Figure 2-8 of the Final EIS, the actual footprint of the proposed tailings area is set back approximately 100 feet from the diversion channel, which would provide an additional degree of slope protection.

Letter 1 Continued

1-11 flows". A leak detection system must be provided in all areas with a potential to leak fluids. The FEIS should provide greater detail on liner design including materials used, thickness, bearing capacity, and wear protection. Run of mill ore is too course to be placed directly on the synthetic liner.

1-12 According to the DEIS (p. 3-80), the heap leach facilities will be zero discharge facilities by incorporating diversion channels, soil liners, drainage collection sights, and leak detection. We recommend that reclamation of the heap leach facilities include capping them with a low-permeability material (no greater than 1 x 10^{-6} cm/sec) in order to preclude meteoric water.

Waste Rock Piles (over/interburden storage areas)

1-13 We are concerned that stormwater would be allowed to pond in the area north of Overburden/Interburden Storage Area A (north of section 16). Waste rock piles should not serve as impoundment structures without infiltration prevention because surface water would flow through the waste rock, thereby potentially generating contaminants to surface waters. It is unclear whether the soil buffer dikes would be constructed concurrent with the waste rock piles to prevent ponded stormwater from infiltrating waste rock during operations as well as after closure. Dikes should be constructed high enough so that, both during operations and after closure, water would be prevented from entering waste rock in section 16 and reentering the Rabbit Creek diversion in sections

1-14 15, 16, and/or 22. Furthermore, you may wish to consider best management practices discussed in "Sector G Metal Mining (Ore Mining and Dressing) Facilities Permit" (Federal Register, Friday, September 29, 1995, pp. 50893-4), which provides more detailed information regarding best management practices than

1-15 Nevada's General Stormwater Permit for the mining industry. We recommend that BLM consider the merits of maintaining the northeast corner of section 16 as undisturbed (e.g., transferring waste rock intended for the northeast corner of section 16 to the southwest corner of section 9 or some other portion of the dump). This could have the additional benefit of providing a wider flood plain.

1-16 The FEIS should address this issue. If the ponding area is a necessary component of the mine, the FEIS should specify its function.

1-17 The DEIS (p. 3-61) states that leachate from the over/interburden waste material from the South pit and Vista pit will exceed many drinking water standards. The FEIS should discuss where leachate would go during mining operations and how it would be prevented from entering surface waters.

Response to Letter 1

1-11 As stated in Nevada Administrative Code 445A.434, the State of Nevada does not require a leak detection system beneath heap leach pads when a synthetic liner is underlain by 12 inches of material with a permeability of 1 x 10-6 centimeters per second. SFPG is exceeding the state requirements by installing a leak detection system under the heap leach pad in areas of high solution flow.

Run-of-mine ore would not be placed directly on the synthetic liners. Instead, a protective layer of finer-grained material would be placed directly on the liner to protect against wear. The basal layer would consist of at least 12 inches of soil (60 percent passing 200 mesh) and 18 inches of minus 3/4-inch gravel or material providing an equivalent level of protection.

1-12 The proposed reclamation of the heap leach pads, as described in Sections 2.4.11.8 and 3.2.2.2 of the Draft EIS, is in compliance with Nevada regulations. As discussed in Section 2.4.11.8 of the Draft EIS, reclamation of the heap leach pads would include revegetating the leach pad surface. Evapotranspiration by vegetation is expected to limit the influx of water through the reclaimed heap leach pad. Placement of a cover with a permeability of 1 x 10-6 centimeters per second would provide a less suitable growth medium for revegetation.

1-13 The soil buffer dikes would restrict infiltration into the overburden and interburden storage area. Additional safeguards would be afforded by the configuration of the storage area itself and the nature of the potentially ponded areas. As described in the Draft EIS (Sections 2.3.3 and 2.4.3), selectively-handled basal and cover layers composed of suitable material would be constructed at the overburden and interburden storage areas. These layers would have net acid-neutralizing capacity and would largely isolate potential problem materials, both chemically and physically. Any ponding that may occur north of storage area A would take place on alluvial materials identical to those that currently exist naturally along the Rabbit Creek/Kelly Creek drainage system. If significant ponding occurred, the accumulation of sediment fines in the ponded areas would act to decrease infiltration rates. The nature of ponded areas near the overburden and interburden storage areas is anticipated to be similar to that of stock ponds in the vicinity.

1-14 In coordination with the Nevada Division of Environmental Protection, SFPG would use *The Nevada Handbook of Best Management*

Response to Letter 1

Practices (Nevada Division of Environmental Protection 1994), which provides substantial detail.

1-15 As shown in Figures 2-5 and 2-8 of the Draft EIS, the northeast corner of Section 16 is proposed to remain undisturbed.

1-16 The stormwater control feature in Section 9 is described in Section 2.4.7.4 of the Draft EIS. Its purpose would be to collect stormwater runoff from disturbed surfaces that are not exposed to process fluids

1-17 Modeling of flow through the overburden and interburden storage areas indicates that leachate from the storage areas would travel vertically through the pile and enter the in situ materials beneath the storage areas several hundred years after mine closure (PTI and WESTEC 1996). Geochemical experiments indicate that potentially acidic leachate would undergo neutralization and attenuation in the in situ materials beneath the storage areas (PTI and WESTEC 1996).

Surface runoff from the overburden and interburden storage areas would not contact the range of materials stored in the piles because the overburden and interburden storage areas would be covered with a minimum of 5 feet of alluvium; therefore, the runoff from the storage areas would contain only constituents leached from the alluvium. As stated on page 3-78 of the Draft EIS, cover material would be selectively handled to ensure that it is acid-neutralizing and that leachate from the material does not exceed the Nevada Division of Environmental Protection's water quality criteria for the Meteoric Water Mobility Testing Procedure.

Letter 1 Continued

1-18 The DEIS (p. 2-51) refers to "capping" the waste rock piles using material with a permeability no greater than $1x10^{-4}$ cm/sec. Such material would be equivalent to silty sand and is not adequate as a cap to preclude meteoric water. We recommend a cap with a permeability of no greater than 1×10^{-6}.

1-19 BLM's preference for the Overburden and Interburden Storage Area Reclamation alternative 2 involves rounding bench corners and contouring the piles with more gradual slopes. We support this alternative because we believe that it will encourage more successful revegetation.

1-20 The carbonate alluvium is to be used to neutralize acidic waste rock. The FEIS should discuss how the required depths of carbonate alluvium beneath the over/interburden waste rock piles were determined (DEIS, p. 2-16).

Water Resources

Rabbit Creek Diversion

The DEIS (p. 3-83) indicates that discharge into Rabbit Creek from pit dewatering would induce degradation in the low-flow channel and that channel downcutting and bank stability may occur for one to two miles downstream of the project area, creating

1-21 localized off-site erosion and sedimentation impacts. The FEIS should identify where treated mine water would be discharged into Rabbit Creek. The FEIS should also identify the designated beneficial uses for Rabbit Creek and discuss the specific impacts discharges of 500 to 3,700 gallons per minute would have on the stream, including water quality and beneficial uses, morphology, and vegetation.

According to the DEIS, the Rabbit Creek diversion channel is expected to fill with sediment (although it states that "periodical removal of deposited sediments" would occur). The structure would then include controlled breach weirs that would direct runoff back to the natural tributary drainages after the Rabbit Creek diversion fills with sediment. These "natural drainages" will be cut off by the placement of storage areas, creating small retention areas. Consequently, overflow spillways would need to be constructed at the retention areas downgradient of the storage area to direct the passage of stormflows around the reclaimed areas. Dikes will also be engineered to minimize infiltration from the retention areas into the storage area, and minimize the possibility of slope failure. If the retention areas overflow or fill with sediment, the overflow spillways are to function as outlet channels to the south. Finally, the natural drainageways, retention areas, and overflow spillways are

Response to Letter 1

1-18 The design of the overburden and interburden storage areas is in compliance with Nevada regulations. As stated on page 2-51 of the Draft EIS, the overburden and interburden storage areas would be covered with a minimum of 5 feet of acid-neutralizing material with a permeability of no greater than 1 x 10-4 centimeters per second. The cover material would serve as a growth medium to revegetate the storage area surface. Evapotranspiration from vegetation, not the permeability of the cover material, would limit the infiltration of water. Lower permeability material (e.g., 10-6 centimeters per second) would be less suitable as a growth medium.

1-19 Comment noted.

1-20 A Monte Carlo simulation technique was developed to predict the net acid-generating potential of the overburden and interburden storage areas. Monte Carlo simulations repeatedly draw random values from the sample populations, perform a calculation, and record the results. Results from all the iterations are statistically analyzed to yield probability distributions for the parameter of interest.

In this study, the Monte Carlo simulation used 10,000 iterations to simulate the stacking of overburden and interburden in a storage area and to determine the net acid-generating potential for the resulting vertical column. In creating the stacked rock assemblage in the storage area, it was assumed that the stack is composed of eight 50-foot lifts of overburden and interburden, that the bottom 50-foot increment is acid-neutralizing material, and that the next 7 increments consist of overburden and interburden stacked in the pile in the order it is removed from the mine (based on mining schedule and the block model). When a possible overburden and interburden storage area stack has been assembled, the simulation calculates the stack's net acid-generating potential by summing the acid-generating potential of the acid-generating materials and subtracting the acid-neutralizing potential of materials that underlie the acid-generating materials.

The Monte Carlo simulation technique was used to calculate probability distributions for long-term acid production at the base of the overburden and interburden storage areas containing South Pit and Vista Pit overburden and interburden. Zones with net acid-generating capacity at the base could potentially release acid to the top of the native foundation. Calculations for the South Pit overburden and interburden storage areas (constructed with a 50-foot basal layer of

oxide material) showed that 1 percent of the overburden and interburden storage area would have greater than or equal to 5,874 kg CaCO3/m2 excess acid at its base (PTI and WESTEC 1996). The thickness of carbonate alluvium required to neutralize the ninety-ninth percentile acid generation potential is approximately 47 feet (based on the acid neutralization potential of the carbonate alluvium). Therefore, where facilities are underlain by a minimum of 50 feet of carbonate alluvium, enough neutralizing capacity exists to completely neutralize potential acidity before it would reach ground water.

However, three of the proposed overburden and interburden storage areas are located in areas where the alluvium does not contain adequate neutralizing potential (rhyolite alluvium) or is too thin to be considered the primary unit between the base of the storage area and the ground water table (storage areas J, M, and N). The ground water under these overburden and interburden storage areas would be protected by considering the excess acid-neutralizing capacity of the bedrock under each facility and requiring a basal layer of carbonate alluvium or Vista Pit oxide material, when necessary. Net-neutralizing potential analyses for the rock types underlying these areas were used to determine a weighted average net-neutralizing potential for the bedrock underlying each storage area. For storage area M, a basal layer of 50 feet of carbonate alluvium would be used in construction to ensure neutralization. For storage area J, basal layers composed of 100 feet of Vista Pit oxide material would provide the sufficient level of protection. Storage area N would be constructed with a 100-foot basal layer of either carbonate alluvium or oxide material mined from the Vista Pit.

1-21 The location where treated mine water would be discharged into the natural drainage system is shown in Figures 2-2, 2-3, and 2-5 of the Draft EIS and on similar figures in the Final EIS. The discussion about the designated beneficial uses for Rabbit Creek has been amplified in Section 3.2.1.2 of the Final EIS. Potential watershed impacts associated with the proposed surface discharges are discussed in the "Watershed Yield, Erosion and Sedimentation" subsections of Sections 3.2.2.2 and 3.2.2.3 of the Final EIS. Potential impacts to aquatic resources are discussed in Sections 3.5.2.1 and 3.5.2.2, and potential impacts to vegetation are addressed in Section 3.4.2.1 of the Final EIS.

Letter 1 Continued

1-22 expected to link up in sequence to pass flows and recreate a drainageway around project components. It is not clear whether the reinfiltration basins will receive water from the Rabbit Creek Diversion Channel/Kelly Creek or from some other source.

EPA is concerned that Santa Fe Pacific Gold Corporation (SFPG) proposes to conduct controlled breaches of the Rabbit Creek diversion structure during post-closure activities and allow the channel to reestablish a natural course. We have the following comments and questions about the design and functioning of this complex system, which should be addressed in the FEIS:

1-23 - It is unclear from the DEIS where the controlled breaching would occur, where the channel will be "allowed" to go, and how long channel reestablishment would take. It appears from the topographic map provided in figure 2-8 that Rabbit Creek would drain into an enclosed basin upon breach of the berm. It also appears that this enclosed basin would only drain after impounding a lake approximately 40 feet deep, with its spillway located in the northeast corner of section 16. "Gradual drainageway reestablishment" would be extremely long-term. The formation of an evaporative lake is likely, as well as water quality degradation and stream alteration. The FEIS should discuss how long channel reestablishment would take and describe predicted water quality in any ponding basins that are anticipated.

1-24 - A detailed topographic map of the system and the location of all of its components, including controlled breaches, should be presented in the FEIS, with the delineation of the expected flow paths of the water around the facilities. EPA also requests that BLM provide us with copies of the detailed WESTEC reports on this system prior to the release of the FEIS.

1-25 - Can the diversion channel be aligned or constructed such that aggradation and subsequent "controlled breaching" is not required? EPA is concerned that this system may require long-term monitoring and maintenance to ensure that it is working. Because the channel is expected to fully aggrade, many other system components must be constructed and properly functioning to accommodate overflow from the channel. Can the channel be located to the extent possible within the natural tributary drainages, perhaps by redesigning or relocating the storage areas to avoid the drainageways? Natural drainageways should have steeper gradients and thus less potential for sedimentation. Perhaps they could be excavated to further increase their capacity. Could an upstream reservoir be constructed to serve as a sedimentation basin, reducing the sediment load into the downstream channel? (This would need to be maintained, but it

Response to Letter 1

1-22 The water to be discharged to the reinfiltration basins would be extracted from the mine dewatering system, as described in Sections 2.3.9 and 2.3.10 (No Action alternative) and Section 2.4.6 (Proposed Action) of the Draft EIS.

1-23 As described in Section 2.4.7 and shown in Figure 2-8 of the Final EIS, controlled breaching would occur along the east side of the overburden and interburden storage area in Sections 16 and 21. Channels could establish in the retention areas relatively quickly (a few years) or could require a long timeframe (tens to hundreds of years), depending on storm and snowmelt events. Evolution of a free-flowing drainage system through the retention areas would take an extremely long time. Materials in the overburden and interburden storage area would be protected from the developing channel system by compacted soil buffer dikes and a system of retention areas and spillways that would direct the evolution of the drainage. In turn, surface water resources would be protected from materials in the overburden and interburden storage area by the system of buffer dikes and retention areas and by isolating the overburden and interburden materials under layers of alluvium applied at the base and along the side slopes of the storage areas.

Because of the proposed management and reclamation of overburden and interburden materials and the location of temporary ponds on surficial alluvium, water quality in temporary ponds is anticipated to be similar to that of stock watering ponds in the surrounding region. A stock pond currently exists in Section 9.

1-24 Further detail on these proposed features has been provided in Figure 2-8 in the Final EIS. The BLM has provided detailed design reports to the EPA; these reports are incorporated by reference in the Final EIS in Sections 2.4.7.1 and 3.2.2.3.

1-25 Additional designs for the Rabbit Creek Diversion (the East Side alternative) have been explored. The diversion cannot be realigned without extensive and deep excavation that would be cost-prohibitive and would substantially add to the amount of surface disturbance. Excavating the existing drainage course would likely induce watershed instability. Building a sediment basin or reservoir upstream of the diversion would probably result in clean reservoir discharges scouring the adjacent channel to reach a sediment transport balance. This option would have minimal effects on the downstream sediment load at the end of the diversion.

Letter 1 Continued

1-25 may be less complex than maintaining all the structures of the currently proposed system).

1-26 - For any of the post-closure scenarios, the FEIS should describe and discuss the monitoring and maintenance measures that would be required by SFPG during channel reestablishment to ensure against undercutting or headcutting of berms, waste rock piles, leach pads, and tailings areas.

1-27 - How can BLM ensure that indeed a final system of drainageways would link up and actually pass flows around all the project components? How deep would the small retention areas be?

1-28 - We recommend that the Channel/Creek receive as much of the 3,700 gpm excess dewatering flow as possible to maximize habitat values within these water bodies (particularly since the infiltration basins will remain unvegetated, and therefore be of minimal value to wildlife). The channel should be designed to accommodate and encourage the growth of riparian vegetation, and still effectively pass flows. Its slopes should be minimally riprapped, and they should be as gradual as is feasible (ideally less steep than 3:1). It should be sized to accommodate the expected roughness of riparian and emergent vegetation, along with maximal dewatering and storm flows. The BLM and SFPG should consult the Fish and Wildlife Service, Nevada Division of Wildlife, the Corps of Engineers and EPA on the design of this system prior to the FEIS.

Clean Water Act Section 404

1-29 We recommend that the applicant (SFPG) consult with the U.S. Army Corps of Engineers to determine whether the project will require an individual (versus a nationwide) Clean Water Act Section 404 permit. If so, the FEIS should include Clean Water Act Section 404(b)(1) alternatives analysis that designates the least environmentally damaging practicable alternative (LEDPA) as specified by the EPA Section 404(b)(1) Guidelines [see 40 Code of Federal Regulations 230]. The DEIS states that the total occurrence of waters of the U.S. within the project area, along with the former Rabbit Creek/Chimney Creek mine project is 15.57 acres (DEIS, p. 3-40). This information is still being verified by the Corps of Engineers, who will then determine if an individual permit is needed.

1-30 If an individual permit is required, EPA will need more detailed documentation as to why some of the less environmentally damaging alternatives are not feasible or practicable in terms of cost, logistics, and technology. For example, the partial South Pit backfill should be more fully analyzed, since it would eliminate

Response to Letter 1

An alternative to the Rabbit Creek Diversion has been presented (Section 2.5.1.5) and evaluated (Section 3.2.2.4) in the Final EIS.

1-26 Mitigation measures WR-9 and WR-10 in Section 3.2.4 of the Final EIS address this issue. In addition to these measures, reclamation monitoring is required and bonded by the Nevada Division of Environmental Protection reclamation permit program. Postclosure monitoring would involve inspecting the controlled breach weirs for proper functioning, observing the remainder of the diversion for uncontrolled breaches and their potential significant threats to downstream features, inspecting the soil buffer dikes, and ensuring that the overflow spillways can function properly. With respect to the proposed diversion and secondary drainage system, headcutting or undercutting are of concern only in Sections 16, 21, and 28, since all other project components are located well away from channel features. Monitoring would include these areas, as would any maintenance activities, if needed.

1-27 The postmining drainage components along the east side of Sections 16, 21, and 28 would eventually be linked because of the downgradient flow direction designed into the system. Each successive retention area and overflow spillway would be lower in elevation than the one above, and outflow from the system would drain down to the Kelly Creek channel.

Depending on the retention area and actual spillway construction, the retention areas along the east side of the overburden and interburden storage area could collect runoff to maximum depths of 10 to 20 feet before the spillway outlets begin downcutting. Shallower maximum depths would be retained after that point. The retention area in Section 9 could pool runoff to a depth of 20 feet. Average depths in the retention areas would be much shallower than the maximums, and long-term pooling in the retention areas would require substantial snowmelt or storm runoff, which has a relatively low probability of occurring in any given year. Annually, approximately 3.5 to 4 feet of evaporation occurs in the area from pond surfaces. It is possible that in some years, pools having water quality similar to stock ponds in the region could exist in the retention areas.

Response to Letter 1

1-28 The purpose of the Rabbit Creek Diversion would be to divert natural storm runoff away from the project components, not to route mine water. Routing dewatering flows into the diversion would require that water flow uphill from the pit or treatment plant. The diversion would be constructed in an ephemeral setting where flows would only occur periodically in response to thunderstorms or snowmelt. At present, riparian vegetation does not occur along the reaches of Rabbit Creek that would be affected by the diversion (see Section 3.1.4.2 in the Final EIS), and attempts to establish new riparian communities along the diversion are likely to be unsuccessful because of limited soil moisture. Even if riparian areas or wetland mitigation measures could be sustained during operations by routing pit water to these areas, they would fail when dewatering flows ceased at the end of mining.

1-29 SFPG has an approved Nationwide Section 404 Permit from the U.S. Army Corps of Engineers for the Proposed Action. The Agency Preferred Alternative may require further consultation with the Corps.

Letter 1 Continued

1-30 the South Pit Lake (and thereby alleviate the long term impacts on surface water resources of the pit refilling with ground water), and reduce the surface area needed for the storage areas (thereby reducing or eliminating the fill of Rabbit Creek). SFPG must also provide a detailed mitigation plan to offset losses of waters of the U.S. that would result from the proposed action. EPA wetlands regulatory staff will be glad to meet with BLM and SFPG to discuss these issues in detail.

1-31 It is unclear from the DEIS (p. 2-34) whether the West and Far West Side Diversions would be designed to adequately contain the 100-year, 24-hour storm event. We recommend that these diversions be designed with a minimum 100-year, 24-hour capacity.

Water Quality

Impacts such as those associated with groundwater drawdown and the Rabbit Creek diversion and reestablishment could have significant impacts on the designated beneficial uses and water quality standards for the streams in the Twin Creeks Mine project area. The beneficial uses for the Humboldt River and its tributaries (e.g., Rabbit Creek, Kelly Creek, Jake Creek) include: irrigation, watering of livestock, recreation involving contact with the water, recreation not involving contact with the water, industrial supply, municipal or domestic supply, aquatic life including warm-water fisheries, and wildlife. In addition, there are required standards and requirements to maintain existing higher quality along the affected segment of the

1-32 Humboldt and its tributaries. The FEIS should include a discussion of the beneficial uses for all streams and other water bodies affected by the Twin Creeks project and discuss how beneficial uses and standards would be affected throughout the project and after closure and how BLM and SFPG would ensure protection of beneficial uses and standards.

1-33 No measures are proposed to offset the potential impacts of the infiltration basins related to increasing concentrations or bioaccumulation of metals or other contaminants within foraging wildlife populations, or the spread of avian diseases (p. 3-166 of the DEIS). The FEIS should include a contingency plan for rectifying any such future impacts.

Acid Rock Drainage

1-34 The DEIS (p. 2-28) states that eight percent of the waste rock for this project would be acid-generating. However, no data for static and kinetic tests are provided in the document to support this statement. This information should be provided in the FEIS.

Response to Letter 1

1-30 Please see the response to comment 1-29 regarding SFPG's 404 Permit. Please see the response to comment 11-2 for a discussion of backfilling the South Pit.

1-31 Descriptions of the West Side and Far West diversions have been expanded in the Final EIS in Sections 2.4.7.2 and 2.4.7.3 to address these issues. In addition, the postmining flow capacities of all diversions (peak flow from the 100-year, 24-hour storm) are described in Section 2.4.11.8 of the Final EIS. In addition, mitigation measure WR-9 in Section 3.2.4 of the Final EIS addresses potential reevaluation and reinforcement of the postclosure diversions.

1-32 Additional details describing designated beneficial uses and standards specific to surface water resources in the hydrologic study area have been added to Section 3.2.1.2 of the Final EIS.

1-33 With regard to the quality of ponded water in the reinfiltration basins, Section 3.2.2 of the Final EIS has been revised to include an estimate of the concentrations of constituents, including metals, in the reinfiltration basins. In summary, evaporative concentration is not anticipated to cause a significant increase in solute concentrations in the reinfiltration basins.

The original impact analysis presented in the Draft EIS indicated that the potential evapoconcentration of salts and metals in the sediments associated with the proposed reinfiltration basins and their effects on terrestrial wildlife were unknown. It was assumed that the presence of an anoxic sediment layer could enhance metal bioaccumulation by biotransformation (i.e., methylation) of certain metals (e.g., mercury,

Response to Letter 1

arsenic, and selenium). However, the rate of water infiltration back into the ground (see Section 3.2.2) would limit the accumulation of salts or metals. Any soluble constituents in the water would not likely precipitate out, but would continue to move in the outflow. Therefore, no accumulation of metals or potential bioaccumulation in resident or migratory organisms would be expected. In addition, compliance with effluent limitations in the Nevada Ground Water Discharge permit would prevent risks to wildlife that might drink the infiltration water. The text in Section 3.5.2.1 of the Final EIS has been modified to reflect this analysis; therefore, no additional mitigation is warranted.

1-34 The static and kinetic test data used to characterize the Twin Creeks overburden and interburden materials are summarized in the Draft EIS and presented in detail in supporting documents. Page 3-60 of the Draft EIS (Section 3.2.2.1) states that approximately 4,500 rock samples from the South Pit and 90 rock samples from the Vista Pit were analyzed to determine the net-neutralizing potential of the material (static testing). Similarly, page 3-60 states that 46 rock samples from the South Pit and 5 rock samples from the Vista Pit were analyzed using kinetic testing. The tonnage of acid-neutralizing and acid-generating material to be removed from the pits is summarized in Table 3-12 (page 3-78) and Table 3-16 (page 3-99) of the Draft EIS.

The raw data for static and kinetic testing, incorporated by reference into the Draft EIS, are presented in technical documents prepared by PTI and WESTEC (PTI and WESTEC 1996; PTI 1996; WESTEC 1995d).

Letter 1 Continued

According to the DEIS (p. 2-28), acid-generating and acid-neutralizing material would be randomly placed in waste rock dumps between basal and cover layers of selectively handled acid-neutralizing material. However, the waste rock would be placed in storage piles in the order that it is removed from the pits (DEIS, p. 3-78). Therefore, large quantities of acid-generating waste rock could be concentrated in a few places within the waste rock piles and might not be properly neutralized. For example, 11 percent of the South pit is estimated to be acid-generating. If all of this waste rock is disposed of in one lift, it may need better neutralization/isolation. We recommend that the mining company be required to selectively handle the acid-generating waste rock such that it is admixed with an appropriate amount of neutralizing waste rock to ensure neutralization. 1-35

Water Quantity

The DEIS discusses the potential impacts of ground water drawdown on surface water resources and vegetative and wildlife communities. The proposed action would further reduce baseflows an additional (beyond the "No Action" alternative) 11 percent for the Little Humboldt River and 27 percent for the Hot Springs area (along Evans Creek), although this area would experience a temporary flow increase of around 10 percent during the first 40 years after mine closure. It is unclear whether Jake Creek flows would be reduced: additional data are needed to determine whether its lower perennial reach depends on ground water discharges. Jake Creek is a losing reach during low flow periods, but well data indicate the there is a relatively shallow depth to ground water (78 feet) within the vicinity of the creek. Thus, a connection between the regional ground water table and surface water flows in the creek is feasible.

The DEIS states that moist meadow areas, cottonwoods and willows, and greasewood-dominated communities occur along Kelly and Jake Creeks. Jake Creek, because of its diverse vegetation, provides a greater diversity of wildlife microhabitats than other water sources in the project area. It also supports important game fish species, and up to 40 percent of its trout habitat could be affected by postmining drawdown from the proposed action after 100 years. The proposed action is also expected to affect an unspecified acreage of phreatophytic vegetation (currently mapped as black greasewood, although this apparently was not verified in the field) along the Kelly Creek drainage. The DEIS states that greasewood stands in these areas would be invaded by more xeric species such as shadscale and other saltbush species. This is not deemed to be a significant vegetation impact. Riparian habitat losses (which are generally predicted but unspecified in terms of acreages) from the proposed action along Jake Creek,

Response to Letter 1

1-35 The analysis of the potential for acid generation by the overburden and interburden storage areas (described in the response to comment 1-20) takes into account the order in which the overburden and interburden would be placed in the storage areas. The proposed mining schedule for removing material from the pits is incorporated in the probabilistic acid-base accounting, which estimates the potential for acid to migrate vertically to ground water. The probabilistic acid-base accounting incorporated a 20 percent reduction in neutralizing potential relative to measured neutralizing potential to ensure that the estimates were conservative. According to the proposed mining schedule, the maximum fraction of potentially acid-generating material removed from the pit during any year is 24 percent (PTI and WESTEC 1996). The probabilistic acid-base accounting analysis performed by PTI and WESTEC (1996) and presented in the Draft EIS characterizes the range of conditions likely to occur at the Twin Creeks Mine and shows that random mixing would be adequate to neutralize acidic leachate.

Letter 1 Continued

Little Humboldt Creek and the Hot Springs could significantly affect regional wildlife resources, including big game mammals, upland game birds, and nongame birds and mammals.

Additional springs and seeps in the Osgood and Snowstorm Mountains that are connected to ground water could be adversely affected by the proposed action, but the DEIS states that because such springs have not been documented or monitored "the extent of these potential impacts is unknown" (p. 3-171).

The cumulative impacts of the proposed action in concert with other regional mining and agricultural activities on aquatic resources parallel those of the proposed action, but would result in a greater degree of adverse impacts.

Mitigation described in the DEIS for these impacts include monitoring of the level of drawdown near sensitive surface water resources (Little Humboldt River, perennial reaches of Kelly and Jake Creek and the Hot Springs area). Additional data would be collected along Jake Creek by installing a nested well system to determine whether Jake Creek baseflow is connected to the regional aquifer. Baseline inventories are to be conducted for seeps, spring, and perennial drainages. If significant impacts to riparian resources or sensitive species are identified, the SFPG will coordinate with the resource agencies to identify and implement appropriate mitigation measures.

To offset losses, spring and stream flow augmentation is proposed with water piped from another nearby source or supplied by a new well from the aquifer near the spring or stream. Alternative mitigation may include the improvement of other identified stream reaches, wetlands or riparian corridors, or artificially recharging the ground water system near affected surface water areas. Fishery mitigation measures may also be implemented.

EPA's questions and comments regarding groundwater drawdown from pit dewatering are the following:

We are concerned about the large data gaps that exist regarding the potential significant impacts of the proposed action and cumulative actions. We do not believe that this data collection should be postponed as part of the mitigation program. Instead, to meet the intent of NEPA, which requires full disclosure of the impacts of a major federal action, we recommend that the BLM not release the FEIS until the following information has been collected:

1-36 - A determination of whether Jake Creek flows are influenced by ground water discharges. The project's potential impacts

Response to Letter 1

1-36 The potential impacts to Jake Creek were discussed in Section 3.2.2.3 of the Draft EIS. Additional monitoring and analyses were specified in mitigation measure WR-4 to determine whether the assumption of

Letter 1 Continued

1-36 to flow, water quality, and aquatic and riparian habitat in Jake Creek appear to be significant. It is unclear why pump tests would be conducted over the next one to two years rather than now, before BLM approves the mining plan. More specific information regarding the effects of groundwater drawdown should be included in the FEIS. Furthermore, the discussion of mitigation measures for these impacts is inadequate in the DEIS. More detailed information is needed regarding potential mitigation measures, including the feasibility and impacts of pumping groundwater to augment stream flows. We recommend that pump tests and modeling be conducted and an adequate mitigation plan be developed and discussed in the FEIS. If pump tests are not conducted prior to the FEIS, we would recommend that a mitigation plan be developed and provided in the FEIS based on the assumption that the project would result in the most severe impacts noted in the DEIS (pp. 3-173 and 3-174).

1-37 - The DEIS provides baseflow estimates for the Little Humboldt River and Hot Springs, as well as estimates of the flow reductions that would result from pit dewatering and subsequent groundwater drawdown. However, average high flows and low flows should be provided in the FEIS for the wet and dry seasons to provide a more accurate description of these waters. In addition, the projected percentage flow reduction in the wet and dry seasons should be provided in the FEIS.

1-38 - A completed survey of the springs and seeps in the Osgood and Snowstorm Mountains, and the extent of impact predicted for these resources.

1-39 - A field characterization and approximate map of the vegetative composition of the potentially impacted phreatophytic community along Kelly Creek: in particular, what other species besides black greasewood exist in this area? Are there significant areas of cottonwood/willow or other species of riparian vegetation?

1-40 Once the project's potential impacts are more fully determined, a specific, proactive mitigation program to offset expected ground water drawdown impacts to aquatic resources should be developed and included in the FEIS. SFPG should coordinate with the BLM, FWS, NDOW, EPA, and the Corps to design this program. The mitigation measures proposed in the DEIS are too vague and, other than the proposed monitoring measures, are all to be carried out after the impacts have occurred. EPA is concerned about this approach since there may be no responsible party to fund and implement the mitigation program by the time the impacts have

Response to Letter 1

potential impacts to the lower perennial reach of Jake Creek is realistic. The additional data collection could either substantiate or disprove the assumption used in the Draft EIS - that impacts to flow in Jake Creek could occur. The Draft EIS assumes that flow may be reduced or eliminated in the lower perennial portion of Jake Creek located within the defined 10-foot drawdown contour. This assumption is conservative and likely represents an evaluation of the "most severe impacts," as suggested in the comment. Mitigation measure WR-4 has been revised in Section 3.2.4 of the Final EIS to state that the additional monitoring along Jake Creek would be accomplished within 1 to 2 years after issuance of the Record of Decision. Mitigation measure TW-4 in Section 3.5.4 of the Final EIS addresses off-site mitigation for terrestrial and aquatic habitat.

1-37 All of the readily available stream flow data for the hydrologic study area, including flow data from two gages monitored intermittently on the Little Humboldt River downstream from Chimney Reservoir and the Hot Springs, are presented in an HCI numerical modeling report (HCI 1996a) and were incorporated by reference into the Draft EIS. The data set includes high and low flow measurements.

With respect to the request that an average reduction in flow be provided for both the wet and dry seasons, baseflow, by definition, represents the ground water component of flow and not the runoff component of flow. As a result, during low-flow periods when there is no runoff contribution to the stream, the low-flow measurements reflect the baseflow conditions. The average low-flow values for the Little Humboldt and the Hot Springs are considered the best available estimates of the average baseflow to the stream. Pit dewatering activities are not predicted to change the runoff contributions to the streams or rivers in the study area. The estimated reductions in baseflow summarized in the Draft EIS are presented as both a reduction in flow as cubic feet per second to the stream and as a percentage of baseflow. The potential change in cubic feet per second would occur regardless of whether the stream is flowing high or low. However the maximum effects to the stream (as a percentage of stream flow) would occur during the low-flow or baseflow period; a time when all of the stream flow is dependent upon discharge from the ground water system. During runoff periods, the percent reduction in flow would be substantially smaller.

1-38 As indicated in the Draft EIS, with a few possible exceptions (such as the Hot Springs, the lower perennial reach of Jake Creek, and the Little Humboldt River), most springs and perennial streams in the area, particularly those springs located in the Snowstorm and Osgood

Response to Letter 1

mountains, are believed to be controlled by perched ground water systems that are situated at least two hundred feet or more above the regional water table. Even though potential impacts to these surface water sources from mine dewatering are not anticipated, an inventory of springs and seeps, with periodic monitoring of representative springs, has been included in mitigation measure WR-3 in Section 3.2.4 in the Final EIS.

1-39 Although minor areas of willow, cottonwood, and other trees occur in the Kelly Creek drainage near the mouth of the canyon where the creek flows out of the Snowstorm Mountains, there are no other areas of willow or cottonwood farther downstream along Kelly Creek, with the exception of the Kelly Creek Ranch. The riparian community near the mouth of the canyon appears to be supported by the perennial streamflow and locally perched water table; therefore, it is not expected to be noticeably affected by regional ground water drawdown from the mining operation. The black greasewood-dominated area mapped in Figure 3-42 in the Draft EIS consists of black greasewood in combination with other common species of the salt desert shrub association, such as shadscale, rubber rabbitbrush, bud sagebrush, basin big sagebrush, Wyoming big sagebrush, inland saltgrass, basin wildrye, alkali sacaton, and bottlebrush squirreltail.

Letter 1 Continued

1-40 occurred, unless BLM is able to collect adequate bond monies specifically for this purpose. Absent an adequate mitigation bond to offset future losses to aquatic resources, it is imperative that proactive mitigation measures be carried out. These could include the restoration or enhancement of existing degraded streams (e.g., fencing off overgrazed areas from cows, fish restocking of depleted streams) on lands that would not be subject to future drawdown impacts.

1-41 We question proposed measures such as the augmentation of spring and stream flows with water from new wells or some other source because of the difficulty of providing this source in perpetuity (e.g, the artificial irrigation system including pumps, pipes, etc. will need to be maintained), and the potential for additional drawdown impacts related to supplying this water.

1-42 Groundwater fluctuations of less than 10 feet can be significant, especially for springs with sensitive species. The FEIS should indicate the potential impacts of groundwater drawdown out to the approximated three-foot drawdown contour. Groundwater contour maps should also be revised accordingly.

1-43 Precipitation inputs for modeling rainfall versus time distribution curves were based on the 1973 Precipitation-Frequency Atlas for Nevada. Have 23 additional years of precipitation data since that time affected the precipitation versus time distribution curves that should be used in designing this project?

Biological Resources

1-44 According to the DEIS (p. 3-180), the project would result in potential toxic effects to wildlife from elevated levels of antimony in the pit lake after mine closure. However, this residual impact is not addressed anywhere else in the document. Furthermore, measures to avoid or mitigate this impact are not addressed. The FEIS must address these issues.

1-45 For purposes of the operating permit, we recommend that specific goals be stipulated for revegetation success, based on the undisturbed areas in the vicinity, and provided in the FEIS. The FEIS should discuss the results of ongoing or prior revegetation efforts at the Twin Creeks site. Test plots should evaluate the success of a six-inch layer of growth medium in comparison to a thicker layer. If 12 or more inches would be optimal for achieving natural vegetation diversity and density, more growth medium should be stockpiled for use in reclamation. The FEIS should also discuss contingency measures that would be used should initial revegetation efforts fail.

Response to Letter 1

1-40 Mitigation measure TW-4 in Section 3.5.4 of the Final EIS describes off-site mitigation to offset ground water drawdown effects in Jake Creek, and their impacts on both terrestrial and aquatic resources.

1-41 Flow augmentation is one of many mitigation measures that has been included for potentially impacted perennial sources. The BLM prefers restoration and enhancement over other mitigation measures such as augmentation. However, any mitigation measure to offset impacts would have to be determined on a site-by-site basis with close coordination between the BLM, the Nevada Division of Wildlife, and other appropriate state and federal agencies. These measures would have to comply with Nevada Division of Water Resources regulations.

1-42 As stated in Section 3.2.2.1 of the Draft EIS, a ground water decline of 10 feet or more was selected to establish the general area of drawdown impacts. This threshold was established by the BLM based on the fact that natural fluctuations in water levels, particularly in fractured rock aquifers (that underlie the perennial water sources in the Osgood and Snowstorm mountains) commonly exceed 10 feet. Drawdowns of less that 10 feet are not generally considered since these changes would probably not be measurable or distinguishable from natural seasonal or annual fluctuations. The 10-foot drawdown has been used as the standard point of reference for most (if not all) of the BLM's EISs for large open-pit mining projects in north-central Nevada for the past several years. However, as stated in the Draft EIS, potential changes or reductions in baseflow to perennial water sources were predicted for streams and springs located both inside and outside of the 10-foot drawdown contour (such as the Little Humboldt River and the Hot Springs area).

1-43 The National Oceanic and Atmospheric Administration Atlas, Volume VII, which is the industry standard reference, was used for Nevada precipitation frequency values in flood simulations, as required by Nevada Division of Environmental Protection regulations (Nevada Administrative Code 445.24272).

Response to Letter 1

It should be noted that the values used were precipitation depths for various frequencies of recurrence (e.g., 10-year, 25-year, 100-year) that were developed by the National Oceanic and Atmospheric Administration using an involved statistical and hydrometeorological approach. Values such as these are presented in standardized government references developed for, and legally accepted by, both the public and private sectors. Revisiting that information with additional data may be appropriate for an authorized government agency (such as the National Oceanic and Atmospheric Administration) or a cooperative effort, but it is beyond the scope of a site-specific EIS.

1-44 The statement on Page 3-180 of the Draft EIS refers to the screening-level risk assessment; it does not apply to the baseline risk assessment. To prevent confusion, this statement has been omitted from Section 3.5.5.1 of the Final EIS. Please see the responses to comments 1-54, 10-3, and 11-42, in addition to the attachments to Appendix C of the Final EIS for additional information on the process and assumptions used in the ecological risk assessment.

1-45 Reclamation approaches, bonding, and success criteria would conform to existing standards developed through guidelines and memoranda of understanding between the Nevada Division of Environmental Protection and the BLM, as well as state regulations as put forth in the Nevada Administrative Code 519A. This has been clarified in Section 2.4.11.2 of the Final EIS.

Letter 1 Continued

1-46 The DEIS (p. 3-168) states that "migrating birds would likely avoid the mine area during project operations." This statement is completely unsupported. In fact, many birds, including sensitive species and migrating birds, die in solution ponds, nets, and other facilities at mine sites. This statement should be deleted in the FEIS.

1-47 Groundwater drawdown from pit dewatering may affect phreatophytic vegetation communities growing in the Kelly Creek drainage (DEIS, p. 3-139). This would result in a gradual reduction in density of greasewood and invasion by more xeric saline/alkaline-tolerant species such as shadscale and other saltbush species from adjacent communities. The FEIS should discuss the measures that would be taken to ensure that undesirable species such as cheatgrass do not invade these areas.

1-48 The DEIS (p. 3-163) indicates that SFPG is working with the appropriate agencies to prevent further wildlife cyanide-related mortalities on heap leach pads. It is unclear whether the mortalities were in solution ponds at the heap leach pads or on the pads themselves. Measures such as covering each lift with a layer of coarse ore material prior to laying out solution lines may help prevent ponding on leach heaps.

Ecological Risk Assessment

1-49 [Appendix C: Ecological Risk Assessment] The spotted sandpiper, which feeds along shorelines, is discussed as a possible receptor, although no shoreline, or littoral, habitat is predicted for the pit lakes (Table C-2: Predicted Pit Lake Habitat Conditions) under either the no action or proposed action alternatives until the lakes reach equilibrium. This discrepancy needs to be addressed.

1-50 [Table C-8: Hazard Quotients for Affected Species, Screening-Level Risk Assessment and C-10: Hazard Quotients (HQ) for Affected Species, Baseline Risk Assessment] There is no discussion of the difference in habitat between the developing north and south lakes, nor are they distinguished in the predicted lake characteristics and habitat tables. The HQ values presented for north and south are very different. The reason for developing different hazard quotients for north and south should be explained in the text.

1-51 The thallium HQ for the cliff swallow is missing from Table C-8, No Action Pit Lake.

1-52 It is not clear in Appendix C why some HQs fall and then rise, some remain relatively constant and others fall over the 230-year

Response to Letter 1

1-46 This statement was misinterpreted; it was not meant to include all bird species, but to communicate the fact that migratory peregrines would not be attracted to the immediate mine area because of the lack of suitable habitat. This text has been modified in the Threatened, Endangered, or Sensitive Species subsection of Section 3.5.2.1 in the Final EIS to clarify the impact assumptions and analysis.

1-47 A number of aggressive, weedy species, such as cheatgrass and halogeton, are already present in varying amounts in almost all local native plant communities. These species tend to flourish in situations involving soil disturbance and lack of effective competition from perennial species. The expected impacts to phreatophytic species, such as black greasewood, would develop slowly over a period of several years as the cone of ground water depression expands outward. This slow progression of ground water impacts would likely result in the death of scattered greasewood plants rather than the immediate mortality of the species over a broad area. The progressive mortality over the affected area may span several decades, facilitating a gradual expansion of other perennial shrubs and grasses that may compete effectively with weedy species in the small openings occurring in the greasewood community.

1-48 As stated in Section 3.5.2.1 of the Draft EIS for the No Action alternative, previous mine records report cyanide-related mortalities; however, no cyanide kills have occurred within the last few years. SFPG has committed to either physically exclude wildlife from cyanide facilities or maintain free cyanide at these facilities below lethal levels. This commitment is presented in Sections 2.3.6 and 2.3.7 of the Draft EIS and is in accordance with the BLM's cyanide management policy and the Nevada Division of Wildlife's Artificial Industrial Pond Permit (Nevada Revised Statutes 502.390), which coincides with the statement in Section 3.5.4.1 that SFPG would follow applicable federal and permit requirements to determine if additional mortalities are resulting from operating cyanide facilities. Text has been added to Section 2.3.7 of the Final EIS stating that wildlife exclusion devices would be developed for the heap leach facilities if pooling of the cyanide solution became apparent, and that SFPG is committed to working with federal and state agencies to prevent further mortalities.

Response to Letter 1

1-49 As discussed in the ecological risk assessment (Parametrix 1996) and summarized in the Draft and Final EIS, no vegetative shoreline (riparian) or shallow-water littoral zone habitat would be expected until the lake reaches equilibrium. As mentioned in the ecological risk assessment, significant littoral habitat was defined as the presence of sufficient emergent and submergent vegetation to attract wildlife species, such as waterfowl, for more than a few days. However, during the entire development of the lake, non-vegetated rocky shoreline favored by species such as killdeer and spotted sandpipers would likely be present. Spotted sandpipers would be expected to forage on adult chironomids (emerging from deeper water habitats) and the few rocky-bottom aquatic invertebrates, if any, mobile enough to keep pace with the rising water levels. Chironomids adapted to deep water habitats would be expected to occur at all three lake levels (5-year, 27-year, and equilibrium). In summary, although littoral habitat would be minimal, it is likely that spotted sandpipers would be present around the pit lake following mine closure. Exposure pathways and exposure routes for the spotted sandpiper during the 5-year scenario in Tables C-4 and C-5 have been corrected in Appendix C in the Final EIS. Because of the presence of some chironomids during this period, these tables have been modified to reflect possible food and water exposure pathways, which would represent chronic exposure routes for this shorebird species.

1-50 Once dewatering ends after mine closure, each lobe of the proposed Twin Creeks pit lake would fill at the same rate (PTI 1996). Therefore, predicted habitat development and exposure scenarios are identical for the north and south lakes. However, chemical concentrations in the north and south lakes are predicted to differ because of the differential distribution of minerals in the proposed mine pit (PTI 1996). This difference is caused by the presence of acid-generating material in the south portion of the pit. Consequently, separate hazard quotients were developed for the north and south lakes based on the different chemistry predicted to be present in each lake prior to their merger.

1-51 The thallium hazard quotients for the cliff swallow were omitted from Table C-8 in the Draft EIS since these values were all less than 1.0. Please refer to the footnote to Table C-8 in the Draft EIS.

1-52 Since the toxicity reference value remains constant for all time periods (unless exposure changes from acute to chronic or vice versa), it is the dose that dictates the magnitude of the hazard quotient. The dose can change depending upon either the concentration in the media (in this case water) or the route of exposure (water, food, or both). In most cases, shifts in the hazard quotient are caused by changes in the

Response to Letter 1

predicted water concentration. The predicted chemical concentrations for the future Twin Creek pit lakes were based on a series of environmental fate experiments conducted in the laboratory using ground water extracted from the perimeter of the proposed pit (PTI 1996). As the lake fills, distinct portions of the geologic material would be exposed to ground water. As this material comes into contact with the ground water, different metals (with varying concentrations) would be leached into the lake. This is particularly true in the south lake, where acid-generating material would lower the pH of the ground water as it passes through the geologic material and fills the lake (PTI 1996). Thus, environmental fate processes that control metal solubility in leachate and lake water would change as the lake fills. This would result in varying concentrations present in lake water at subsequent times, which would result in the observed differences in the predicted hazard quotients (Parametrix 1996). Finally, as the lake nears equilibrium, evaporation would become an important factor influencing predicted metal concentrations. Consequently, predicted concentrations for some metals would rise in the equilibrium period as they become more concentrated because evaporation would be greater than predicted inflow and precipitation for most years (PTI 1996).

Letter 1 Continued

1-52 period after mining, by the end of which the pit lake is expected to reach hydraulic steady state. The processes, factors and values applied for each of the three discrete years under analysis should be provided in the text. Where this has been discussed in the body of the DEIS, those sections should be cited.

1-53 [Section C-2 Baseline Risk Assessment] It is stated that the no-observed-adverse-effect-level used in the screening-level risk assessment was taken from a study of rat longevity. The baseline risk assessment value was taken from a study of reproduction in ewes. The studies cited should be referenced.

1-54 Considering that the receptors of interest, two birds and a bat, are closer, at least in size, to the rat, it is not clear why a value taken from a study of ewes would reduce uncertainty in this risk assessment. The choice of study and value needs to be explained more fully.

Response to Letter 1

1-53 Based on this comment, the references in question (Schroeder et al. 1970; James et al. 1966) are provided in Chapter 6 of the Final EIS. In addition, all references pertaining to the ecological risk assessment can be reviewed in the ecological risk assessment document (Parametrix 1996) on file with the BLM.

1-54 The screening-level risk assessment identified potential risks to wildlife from antimony. Hazard quotients were as high as 46 for the little brown myotis. In the subsequent baseline risk assessment, the toxicity reference value for antimony was re-evaluated (see Section C.2 of Appendix C of the Draft EIS). The original toxicity reference value of 0.035 milligram per kilogram per day in the screening-level risk assessment was replaced by 2 milligrams per kilogram per day in the baseline risk assessment. Since the 2 milligrams per kilogram per day value is based on an actual chronic endpoint of reproduction in female sheep rather than longevity in rats (from which the 0.035 milligram per kilogram per day value was derived), it is more representative of concentrations that may affect populations, thereby reducing the uncertainty of estimating population-level risks. In contrast, extrapolating from a longevity reduction endpoint to a population-level endpoint introduces additional uncertainty to the analysis. No body size adjustment of toxicity reference values was made in the risk assessment. However, because of the higher water ingestion rate, slower metabolic rate, and slower clearance rate of heavier animals, a toxicity reference value protective of a larger animal, such as a ewe, is likely to be very protective of a smaller animal, such as a bat or bird.

In addition, while toxicity reference values in the screening-level risk assessment were no-observed-adverse-effect levels or their equivalent, toxicity reference values of the chemicals of potential concern (identified in the screening-level risk assessment) in the baseline risk assessment were chronic values, which are arithmetic means of the no-observed-adverse- effect level and lowest-observed-adverse-effect level. Chronic values have been historically used by the U.S. Environmental Protection Agency to establish chronic limits and are a better measure of concentrations or doses at which adverse effects will occur. No antimony doses exceeded the revised toxicity reference values in the baseline risk assessment; all antimony hazard quotients were less than 1 (see Table C-10 in Appendix C of the Draft EIS).

A more detailed description of the assumptions used and process followed in the baseline risk assessment is presented in Attachment C1 to Appendix C of the Final EIS.

Letter 2

United States Department of the Interior

FISH AND WILDLIFE SERVICE
NEVADA STATE OFFICE
4600 KIETZKE LANE, SUITE 125C
RENO, NEVADA 89502-5055

September 3, 1996
File No. BLM 10-4

Memorandum

To: District Manager, Winnemucca District Office, Bureau of Land Management, Winnemucca, Nevada (Attn: Gerald Moritz)

From: State Supervisor, Nevada State Office, Reno, Nevada

Subject: Twin Creeks Mine Draft Environmental Impact Statement

The Fish and Wildlife Service (Service) has reviewed the July 1996 draft environmental impact statement (DEIS) for Santa Fe Pacific Gold Corporation's Twin Creeks Mine. The DEIS analyzes impacts associated with consolidation and expansion of existing gold mining operations at the former Rabbit Creek and Chimney Creek Mines at a site approximately 35 miles northeast of Winnemucca, in eastern Humboldt County, Nevada. The project would expand the South Pit; develop additional waste rock storage areas, as well as additional milling, flotation, heap leaching, and tailings facilities; expand the existing dewatering system and water disposal facilities; and divert Rabbit Creek and tributaries around the mining and processing areas. The mine expansion will disturb an additional 5,217 acres of land beyond that of the current project.

GENERAL COMMENTS

2-1 We recommend the project proponent develop additional measures to avoid, reduce, or compensate for significant impacts to fish and wildlife resources that would result from the proposed mining project. Compensation for temporal loss of fish and wildlife resources, habitat fragmentation, loss of riparian ecosystems, and other impacts could include reclamation of other Federal lands disturbed by past mining activities, placement of monies into a fund for restoration, or enhancement of other disturbed areas. Sites used to compensate for permanent or long-term impacts should be set aside in perpetuity by closing these areas to mineral entry.

Response to Letter 2

2-1 Monitoring and/or mitigation measures were developed for impacts that were determined to be potentially significant to terrestrial wildlife and special status species. Mitigation measure TW-4 in Section 3.5.4 of the Final EIS has been revised to address off-site habitat enhancement. Please see the responses to comments 1-36, 1-40, and 10-1 for additional information pertaining to this issue. In addition to this mitigation measure, Section 3.5.4.1 in the Draft EIS describes the proposed monitoring plans that would be established in order to determine the level of effects anticipated from specific mining components or activities (e.g., dewatering). Also, mitigation measure TW-4 has been clarified in the Final EIS, based on comments received on the Draft EIS. Mitigation measures WR-5 in Section 3.2.4; TW-2, TW-3, and TW-4 in Section 3.5.4.1; and AB-1 and AB-2 in Section 3.5.4.2 all refer to proposed monitoring plans, followed by applicable mitigation measures, if necessary. SFPG would coordinate with federal and state agencies in developing these plans and measures, since specific problem-solving approaches would vary, depending on the issue.

Letter 2 Continued

2-2 We also recommend that only native plant species indigenous to the area be used in reclamation. The goal should be restoration of native ecosystems as well as reduction of soil erosion potential.

2-3 Under the Migratory Bird Treaty Act (15 U.S.C. 701-718h) (MBTA) it is unlawful to kill migratory birds, and no permits are issued to allow take of migratory birds. We recommend preventing access by all wildlife to toxic solutions associated with solution ponds, puddles on top of heap leach pads, and in solution collection channels.

2-4 In addition, land clearing activities should be timed to avoid the potential for destroying active bird nests and/or their contents in the area. Such destruction may be a violation of the MBTA.

SPECIFIC COMMENTS

CHAPTER 2. DESCRIPTION OF THE PROPOSED ACTION AND THE ALTERNATIVES

2-5 2.3.7 Development of an Additional Heap Leaching Facility, page 2-18, paragraph 4. The use of drip emitters or sprinklers on top of heap leach facilities have caused incidental migratory bird deaths. Other techniques such as buried drip lines should be considered to reduce the potential for incidental wildlife mortality.

2-6 2.4.4.3 Additional Tailings Storage Facilities, page 2-30, paragraphs 6 and 8. The DEIS states that a synthetic liner may be used at tailings area B and that tailings area D may or may not be synthetically lined. The Service recommends that synthetic liners be placed under both tailings ponds to preclude risks of contamination to ground water.

2-7 2.4.11.5 Tailings Storage Area Reclamation, Revegetation, page 2-41, paragraph 2. Tables 2-7 and 2-8 identify proposed reclamation seed mixtures. These mixtures contain non-native, introduced plants such as crested wheatgrass and annual ryegrass. We recommend the use of native, indigenous plant species to prevent the further spread of non-native vegetation which reduces biological diversity.

2-8 2.4.11.14 Post-Reclamation Maintenance and Monitoring, page 2-48, paragraphs 1 and 2. The final environmental impact statement (FEIS) should provide information on how long ground water monitoring and fence/sign maintenance would continue following mine closure.

Response to Letter 2

2-2 As stated in the Draft EIS, the reclamation objectives include the following: "return the mine site to a condition which would support an ecosystem similar to that which existed prior to the onset of mining activities; and control infiltration, erosion, sedimentation, and related degradation of existing drainages in an effort to minimize off-site impacts." The BLM considers a revegetation plant mix composed of native and introduced species to be the most effective approach to achieving these goals.

2-3 Please see the response to comment 1-48 regarding cyanide mortalities and SFPG's commitment to minimize the potential for further wildlife mortalities.

2-4 The removal and disturbance of the vegetation types by proposed mine development and operation were not assessed to be significant to nesting bird populations associated with the sagebrush and grassland communities found in the immediate mine area. The Draft EIS presented a number of mitigation measures that would be implemented if sensitive riparian habitat were to be indirectly and adversely affected by mining operations. Also, please refer to the responses to comments 1-36, 1-40, and 2-1 regarding the development and implementation of applicable mitigation and monitoring measures for this project.

2-5 Buried emitters can cause pooling of cyanide solution, depending on the heap material. Please see the responses to comments 1-48 and 2-23 regarding SFPG's commitment to minimize the potential for cyanide-related wildlife mortalities and to coordinate with the applicable federal and state agencies to develop additional mitigation measures, if necessary.

2-6 Please see the response to comment 1-9 regarding the use of liners beneath the tailings facilities.

2-7 Please see the response to comment 2-2 regarding the use of native plant species.

2-8 The Nevada Division of Environmental Protection would be responsible for determining the duration of postmining monitoring requirements for the pit lake, as discussed in Section 3.2.4 of the Final EIS. SFPG would be responsible for maintaining fences and signs through closure and bond release. As part of bond release, the BLM could negotiate with SFPG to provide all or part of the funds for maintaining fences/signs on public land. However, following bond release, the BLM would be responsible for fence/sign maintenance.

Letter 2 Continued

2-9 2.7 Agency Preferred Alternative, page 2-66, paragraph 1. The alternative of selective handling of overburden and interburden (section 2.5.1.2) was considered in detail earlier in the DEIS. Information should be provided in the FEIS on why this alternative was not included as part of the agency preferred alternative.

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

2-10 3.1.1.3 Mineralization and Pit Geology, South Pit, page 3-10, paragraph 1. There appears to be a typographical error (comma used in place of a decimal?) as to the total ounces of gold mined from this pit through 1995.

2-11 3.2.1.2 Surface Water, Surface Water Quality Standards, page 3-43, paragraph 1, Table 3.5. Several errors or omissions are present in the table. The fluoride standard for watering of livestock is 2000 milligrams per liter (mg/L). The aquatic life standard for boron was dropped by the Nevada Division of Environmental Protection. We are unaware of standards for boron for the propagation of wildlife, copper for municipal or domestic supply, and an aquatic life single sample limit for silver. Also, the standard for thallium for municipal or domestic supply should be 0.013 mg/L, not 0.13 mg/L.

2-12 3.2.1.3 Ground Water, Ground Water Quality, page 3-50, paragraph 1. Selected water quality results were presented in Table A-2, as referenced here. The FEIS should report on additional constituents, especially boron and nickel. Boron concentrations tend to be elevated in some surface waters in Nevada, with potential adverse impacts on biota. Concentrations of boron in ground water may affect pit lake water quality and ultimately wildlife resources, especially birds.

2-13 3.2.4 Monitoring and Mitigation Measures, pages 3-107 to 3-109. Water quality information will continue to be collected on a quarterly basis from all designated water quality monitoring stations and will be analyzed based on the Nevada Division of Environmental Protection (NDEP) Profile I constituent list. The list includes boron as one of the constituents. Why were boron results not included in Table A-2? Boron data should also be included in Table 3-15 "Median Predicted Chemical Concentrations in the Proposed Action Pit Lake."

2-14 Pit lake water quality monitoring will be required by NDEP as part of postclosure monitoring requirements to demonstrate that the pit lake would not have the potential to adversely affect waters of the state or terrestrial or avian life. The Service endorses the need for monitoring. However, mitigation measures must be included in the FEIS to describe what would be done

3

Response to Letter 2

2-9 The Selective Handling of Overburden and Interburden alternative (Section 2.5.1.2) was not included in the Agency Preferred alternative because the selective handling of the overburden and interburden would not improve protection of water resources compared to random emplacement of overburden and interburden.

Table F-1 below summarizes the results from the Monte Carlo simulations of the potential for acid generation at the base of the overburden and interburden storage areas. Results are shown for both random emplacement of overburden and interburden (Proposed Action) and selective handling of overburden and interburden (alternative).

Table F-1
Net Acid-Generating Potential

Basal Layer	In Situ Alluvium Type	Percent of Storage Area with Net Acid-Generating Potential Below Basal Layer	Depth of In Situ Alluvium Required to Neutralize 99% of Acid
Random Emplacement (Proposed Action)			
50 feet oxide	carbonate alluvium	15	47 feet
50 feet carbonate alluvium	rhyolite alluvium	2	56 feet
Vista Pit overburden and interburden		5	5 feet
Selective Handling (alternative)			
150 feet carbonate alluvium	carbonate alluvium	5	32 feet

2-10 The typographical error regarding the number of ounces of gold that have been extracted from the South Pit has been corrected in the Final EIS.

2-11 Table 3-5 has been updated in the Final EIS to reflect the most current Nevada standards for beneficial uses.

2-12 Table A-2 in the Final EIS have been revised to include boron and nickel.

2-13 As stated in the response to comment 2-12, boron has been added as a constituent to Table A-2 in the Final EIS. In addition, Table 3-18 has been revised to include predicted concentrations of boron in the Proposed Action pit lake. Boron concentrations were predicted by PTI using the methods described in the pit lake water quality report (PTI 1996). The predicted median concentrations for boron do not exceed water quality standards.

2-14 As stated on page 3-107 of the Draft EIS, pit lake water quality monitoring would be required by the Nevada Division of Environmental

Response to Letter 2

Protection as part of postclosure monitoring. The objective of the pit lake monitoring would be to demonstrate that the lake water quality is in compliance with Nevada Administrative Code 445.24352 and would not degrade waters of the state or adversely affect the health of human, terrestrial, or avian life. As summarized in the Draft EIS, the results of the pit lake water quality predictive study and pit lake ecological risk assessment indicate that no significant adverse impacts are anticipated from the pit lake. Therefore, no specific mitigation measures are proposed. Mitigation measure WR-6 has been added to Section 3.2.4, however, to address any unanticipated water quality problems associated with the future pit lake. In addition, please see the responses to comments 1-36, 1-40, and 2-1 regarding the development and implementation of applicable mitigation and monitoring measures for this project.

Letter 2 Continued

2-14 in the event that monitoring data indicate adverse effects are occurring or are likely to occur in the future. Concentrations of metals and trace elements in avian food items from the pit lake should also be monitored to determine risks to birds.

2-15 3.5.1.1 Terrestrial Wildlife, Wildlife Habitat, page 3-145, paragraph 7. It is stated that existing conditions at some springs near the mine reflect overuse of the mesic vegetation. Is this overuse a result of cattle grazing? If so, we recommend the mitigation of excluding cattle from this sensitive and valuable wildlife area.

2-16 3.5.1.3 Threatened, Endangered, or Sensitive Species, Mammals, page 3-159, paragraph 4. A reference should be cited for the statement that pygmy rabbit habitat often occurs along riparian areas. Based on our literature reviews, pygmy rabbits are thought to be able to obtain all necessary free water from the surface of vegetation or from the vegetation itself since they are often found miles from free water (Larrison and Johnson 1981).

2-17 3.5.2.1 No Action Alternative, Terrestrial Wildlife, page 3-162, paragraphs 1 and 3. It is stated that reclamation measure (1) would create nesting areas in the pit high walls; however, this measure was not identified in Section 2.4.11 on pages 2-35 and 2-36 as referenced here. The FEIS should identify the target species for this mitigation measure, whether this species habitat has been destroyed or eliminated as a result of past or projected mining activities, the type of nesting structure proposed, and any potential indirect impacts on the prey base or potential for bioaccumulation of toxins as a result of use of the proposed nest structure.

2-18 Reclamation measure (5) states that a perimeter fence would be installed and maintained to exclude livestock and wild horses. This statement infers that the fences would remain in perpetuity. Whereas, on page 2-36 it states that a perimeter fence would be installed to prevent livestock grazing on the project area for at least 2 years after seeding. This apparent discrepancy should be clarified.

2-19 In paragraph 3, it is stated that direct bird mortality would occur as a result of mining activities. This may be a violation of the MBTA. Therefore, we recommend all land clearing activities be timed to avoid the potential for destroying active bird nests and/or their contents in the area.

Response to Letter 2

2-15 The description of the mesic vegetation associated with the lower elevational springs near the mine was intended to describe the springs' current conditions as part of the baseline discussion under the National Environmental Policy Act. Whether this condition was caused by livestock grazing, mining operations, or recreational activities has not been documented. Baseline information is provided in order to assess final impacts in the event that the resource is affected by the proposed project.

2-16 The Draft EIS text referred to the fact that Basin big sagebrush and rabbitbrush are often found along ephemeral drainages in deeper soils; the statement should not have included riparian drainages. To minimize confusion, this statement has been deleted in the Final EIS.

2-17 The specific reclamation measure to create nesting areas in the pit high walls has been removed from the document and would not be pursued as a reclamation option. Because pit water quality would not be optimal for supporting nesting birds, this measure is not considered an appropriate reclamation or enhancement measure.

2-18 This discrepancy has been corrected in both Sections 2.4.11.1 and 3.5.2.1 of the Final EIS.

2-19 Please see the response to comment 2-4 regarding potential impacts to nesting birds from mine development.

Letter 2 Continued

2-20 3.5.2.1 No Action Alternative, Terrestrial Wildlife, Water Quantity Impacts to Terrestrial Wildlife, page 3-166, paragraph 1. It was identified that impacts from evaporation from mine dewatering and reinfiltration activities could adversely affect foraging birds. No mitigation measures appear to be identified for this potential impact. The FEIS should identify measures to prevent this potential impact.

2-21 3.5.2.1 No Action Alternative, Terrestrial Wildlife, Threatened, Endangered, or Sensitive Species, page 3-168 paragraph 3 and page 3-169 paragraph 6. The bald eagle is included as a sensitive species. It should be identified as a threatened species. In the event of a spill in the Humboldt River, it is unlikely that affected fish and birds could be easily removed. It is more likely that dead and dying fish and birds would become highly attractive to bald eagles that are highly opportunistic in their feeding habits. Such a scenario would also result in greater exposure of bald eagles to the contaminant spilled than that described in the DEIS. The FEIS should provide an assessment of these concerns, both with regard to the no action alternative and the proposed action. For actions expected to adversely impact listed species, the Service recommends initiating consultation under section 7 of the Endangered Species Act of 1973, as amended.

2-22 Vegetation clearing during the avian breeding season that results in the destruction of bird nests or their eggs may be a violation of the MBTA. If vegetation clearing must be done during the breeding season, careful surveys must be conducted to insure that no nests are present before proceeding with clearing operations. This also applies to the proposed action.

2-23 3.5.2.2 Proposed Action, Terrestrial Wildlife, Water Quality, page 3-171, paragraph 1. The FEIS should indicate that mortality due to cyanide exposure would likely increase due to the increased life of mine operations.

APPENDICES

2-24 Appendix A, Table A-3, page A-27. An asterisk is missing for the sampled discharge range for arsenic, indicating a value above permit limits.

2-25 Appendix B, Table B-1, page B-1. The scientific name for the bald eagle is misspelled. It should be *Haliaeetus leucocephalus*.

Response to Letter 2

2-20 Please see the response to comment 1-33 regarding the assessment of the reinfiltration basins associated with this project.

2-21 The status of sensitive wildlife species, including the federally threatened bald eagle, is presented in Table 3-27 of the Draft EIS. In order to clarify the differences between species that are federally protected as endangered and threatened and those that are either federal candidates or BLM sensitive, the term "special status species" has been substituted to group these species of concern that are analyzed for this project. This change has been made throughout the Threatened, Endangered, or Sensitive Species sections of the Final EIS.

In response to the comment on potential impacts to bald eagles from the chemical spill scenario, the numbers used for calculating the probability of an accident for the Draft EIS analysis were highly conservative. Sections 3.15.2.1 and 3.15.2.2 of the Draft EIS calculated the number of accidents per million miles traveled for rural two-lane roads. However, the probability of a release from an accident was not considered.

The probability of a release or spill of hazardous materials from a truck accident has been calculated in the Final EIS based on accident statistics for liquid tankers carrying hazardous materials (Harwood and Russell 1990). These statistics indicate that, on the average, 18.8 percent of accidents involving liquid tankers carrying hazardous materials have resulted in a spill or release. The text in Sections 3.15.2.1 and 3.15.2.2 of the Final EIS has been revised to reflect this more accurate spill scenario.

Furthermore, the likelihood of a hazardous materials spill occurring specifically at the Humboldt River bridge along the 35-mile access route to the mine would be much lower than both of the spill probabilities calculated for the EIS, which even collectively are less than 1 accident or spill for the life of the project. But since the probability of a spill occurring is not zero, the EIS includes an analysis

of potential effects to wildlife species associated with the Humboldt River, which includes wintering eagles. As discussed in Section 3.15.2.2, approximately 2 miles of the access route would be located within 1,000 feet of the Humboldt River. Using the same statistics presented in Table 3-55, the calculated probabilities of a spill along this 2-mile segment would be even lower, totaling 8 in 1,000, 23 in 1,000, and 4 in a 1,000 for cyanide, diesel, and acid solutions, respectively.

Given the U.S. Fish and Wildlife's concern with the potential indirect effects to bald eagles from a hazardous materials spill into the Humboldt River, the Final EIS discussion has been modified to represent the federal agency's view. Although the probability of this scenario occurring is very low, Sections 3.5.2.1 and 3.5.2.2 for Threatened, Endangered, or Sensitive Species in the Final EIS acknowledge that if individual eagles were to consume contaminated prey following a spill of hazardous materials into the river, individual injury or mortality might result. If this were to occur, the BLM (as the federal lead agency) would immediately enter into emergency Section 7 consultation with the U.S. Fish and Wildlife Service to prevent or minimize further impacts to wintering or migrating bald eagles.

2-22 Please see the response to comment 2-4 regarding potential impacts to nesting birds from mine development.

2-23 Please see the response to comment 1-48 regarding SFPG's commitment to minimize the potential for cyanide-related wildlife mortalities. In addition, a statement has been added to the Proposed Action discussion in Section 3.5.2.2 of the Final EIS to clarify that the potential for wildlife mortalities would increase over the long term because of the additional life of mine operations. However, as previously stated, SFPG has committed to either excluding wildlife or maintaining the free cyanide below lethal levels, in addition to working with the federal and state agencies to ensure that wildlife mortalities do not increase as a result of mine operations.

2-24 Table A-3 in the Final EIS has been revised to include an asterisk.

2-25 The typographical error in the bald eagle's scientific name has been corrected in Appendix B of the Final EIS.

Letter 2 Continued

2-26 Appendix C, Screening-Level Risk Assessment, Problem Formulation, Receptor Species, pages C-2 to C-4. This section indicates that the mallard may forage on both aquatic plants and invertebrates. However, this is in conflict with information in Table C-6 where percent diet for the mallard is listed as 100 percent plant. The scientific name for the mallard in Table C-3 is misspelled. It should be *Anas platyrhynchos*.

We appreciate the opportunity to comment on the DEIS for this project. If you have any questions, please contact Pam Repp, Stanley Wiemeyer, or Mary Jo Elpers at (702) 784-5227.

Carlos H. Mendoza

cc:
Administrator, Nevada Division of Environmental Protection, Carson City, Nevada
Administrator, Nevada Division of Wildlife, Reno, Nevada
Regional Manager, Nevada Division of Wildlife, Fallon, Nevada
Project Manager, Army Corps of Engineers, Reno, Nevada
State Director, Bureau of Land Management, Reno, Nevada
Chief, Office of Federal Activities, Environmental Protection Agency, San Francisco, California
Chief, Wetlands Section, Environmental Protection Agency, San Francisco, California
Assistant Regional Director, Interior Basin Ecoregion, Fish and Wildlife Service, Portland, Oregon
Assistant Regional Director, Klamath and California Ecoregions, Fish and Wildlife Service, Portland, Oregon

Literature Cited

Larrison, E. J., and D. R. Johnson. 1981. Mammals of Idaho. The University Press of Idaho, Moscow, Idaho, USA.

Response to Letter 2

2-26 The mallard was initially selected as a receptor species to be included in the ecological risk assessment because it is a very common bird, it is frequently found in and around water bodies in Nevada, and it is representative of other waterfowl. The diet of adult male mallards and nonbreeding females is essentially 100 percent vegetation; mallard use of invertebrates is seasonal (mainly hens during the egg-laying period and ducklings during the brooding period) (Martin et al. 1951; Swanson et al. 1985; Chura 1961). In constructing the exposure scenarios, it was determined that it would be unlikely for mallards to nest near the pit lake because of lack of cover and forage (see Section C.1.1.4 of Appendix C of the Draft EIS). Therefore, it was assumed that only nonbreeding adults would be present at the lake during the spring and fall migrations, during which time the mallard diet is nearly 100 percent vegetation (Martin et al. 1951). The typographical error in the mallard's scientific name has been corrected in Table C-3 of the Final EIS.

Letter 3

BOB MILLER
Governor

STATE OF NEVADA

JOHN P. COMEAUX
Director

DEPARTMENT OF ADMINISTRATION
Capitol Complex
Carson City, Nevada 89710
Fax (702) 687-3983
(702) 687-4065

AUG

August 29, 1996

Gerald Moritz
EIS Project Manager
Bureau of Land Management
Winnemucca District Office
5100 East Winnemucca Boulevard
Winnemucca, Nevada 89445

Re: SAI NV # E1997-003

Project: Draft EIS – Twin Creeks Mine
1793/3809, NV-932.8, NV-020

Dear Mr. Moritz:

3-1 Enclosed are the comments from the Nevada State Historic Preservation Office, Division of Minerals, Natural Heritage Program, Department of Transportation, and Division of Water Resources concerning the above referenced project. These comments constitute the State Clearinghouse review of this proposal as per Executive Order 12372. Please address these comments or concerns in your final decision. If you have any questions please contact either me, at 687-6382, or Julie Butler, Clearinghouse Coordinator/SPOC, at 687-6367.

Sincerely,

Terri Rodefer, Environmental Advocate
Nevada State Clearinghouse

Enclosures

Response to Letter 3

3-1 Comment noted.

Letter 4

NEVADA STATE CLEARINGHOUSE

RECEIVED

Department of Administration
Budget and Planning Division
Blasdel Bldg., Rm. 200
(702) 687-4065
fax (702) 687-3983

DATE: July 3, 1996

Governor's Office
Nuclear Projects Office
Business & Industry
Agriculture
Energy
Minerals
Economic Development
Tourism
Fire Marshal
Human Resources
Aging Services
Health Division
Colorado River Commission
Indian Commission

Legislative Counsel Bureau
Communications Bd.
Emp. Training & Rehab.
Research Division
PSC
Transportation
UNR Bureau of Mines
UNR Library
UNLV Library
Wild Horse Commission
Historic Preservation
Emergency Management
Washington Office

Conservation-Natural Resources
Director's Office
State Lands
Environmental Protection
Forestry
Wildlife
Region 1
Region 2
Region 3
Conservation Districts
State Parks
Water Resources
Water Planning
Natural Heritage

Nevada SAI # E1997-003

Project: Draft EIS – Twin Creeks Mine

✓ Yes	__ No	**Send more information on this project as it becomes available.**

CLEARINGHOUSE NOTES:
Related SAI # 95300011.

Enclosed, for your review and comment, is a copy of the above mentioned project. Please evaluate it with respect to its effect on your plans and programs; the importance of its contribution to state and/or local areawide goals and objectives; and its accord with any applicable laws, orders or regulations with which you are familiar.

Please submit your comments no later than **August 26, 1996**. Use the space below for short comments. If significant comments are provided, please use agency letterhead and include the Nevada SAI number and comment due date for our reference. If you have any questions, please contact Terri Rodefer, Clearinghouse Environmental Advocate, at 687-6382, or Julie Butler, Clearinghouse Coordinator, 687-6367.

THIS SECTION TO BE COMPLETED BY REVIEW AGENCY:

✓ No comment on this project at this time
___ Proposal supported as written
___ Additional information below
___ Conference desired (See below)
___ Conditional support (See below)
___ Disapproval (Explain below)

AGENCY COMMENTS:

4-1 The BLM has initiated their Section 106 (National Historic Preservation Act of 1966, as amended) for this undertaking. The SHPO awaits the agency's determination of project effect.

Rebecca L Palmer

August 22, 1996

Response to Letter 4

4-1 Comment noted.

Letter 5

STATE OF NEVADA
DEPARTMENT OF BUSINESS AND INDUSTRY
DIVISION OF MINERALS
400 W. King Street, Suite 106
Carson City, Nevada 89710
(702) 687-5050 • Fax (702) 687-3957

BOB MILLER
Governor

LAS VEGAS BRANCH
4220 S. Maryland Pkwy
Suite 304
Las Vegas, Nevada 89119
(702) 486-7250
Fax (702) 486-7252

RUSSELL A. FIELDS
Administrator

August 22, 1996

Julie Butler, Coordinator
Nevada State Clearinghouse
Department of Administration, Planning Division
Blasdel Bldg., Room 200
Carson City, NV 89710

Re: Nevada SAI #E1997-003 -- Draft Environmental Impact Statement
Twin Creeks Mine -- Santa Fe Pacific Gold Corp.
Due Date: August 26, 1996.

The Division of Minerals has reviewed the Draft Environmental Impact Statement (DEIS) for Santa Fe Pacific Gold Corp. Twin Creeks Mine expansion project.

5-1 Approval of this project will allow Santa Fe Pacific Gold Corp. to develop a very significant mineral resource. This will be of great benefit to Humboldt County, the State of Nevada and the Nation in terms of employment and revenue generation. The mine expansion will provide the means for extended production of an important and very necessary mineral commodity.

The Division supports the Proposed Action as submitted by Santa Fe Pacific Gold Corp.

5-2 If the BLM requires additional overburden/interburden area reclamation activities, the Division supports Alternative 1. Alternative 1 is preferable to Alternative 2 in that it meets Class IV visual resource management guidelines but results in 200 fewer acres of disturbance. Full implementation of Alternative 2 would require encroachment on adjacent private lands.

5-3 NOTE: It would be helpful to have a series of photos and photoenhancements included in the final EIS that show the mine site in various stages of operation and reclamation from designated Key Observation Points. These would be useful in showing the differences in the landscape for employment of the Proposed Action versus Alternative 2 versus Alternative 1. This is one of the very few environmental impact statements the Division has reviewed that does not contain such photos.

5-4 If the partial Vista Pit backfill alternative is required, viability of this action should be examined in terms of: 1/ The environmental costs, i.e., additional fossil fuel consumption and combustion, dust generation, etc., don't outweigh anticipated

Response to Letter 5

5-1 Comment noted.

5-2 Comment noted.

5-3 BLM technical staff decided against including photosimulations in the EIS because of the combination of low visual contrast and low visual impact to sensitive viewpoints or viewers. It was determined that the nature and degree of visual impacts could be adequately analyzed and portrayed without photosimulations.

5-4 The Partial Vista Pit Backfill alternative is considered economically viable by SFPG; the economic evaluation considered the potential for

Letter 5 Continued

5-4 benefits; 2/ The backfill material does not bury mineral resources that may one day become economically viable, and 3/ The costs in manpower and equipment use from multiple or long-distance haulage of material are not found to be excessive when compared to other storage scenarios.

5-5 The post-mining safety plan for the open pits is very good (pp. 2-47 and 2-48). The use of fences and/or berms posted with warning signs, and the destruction by blasting of pit access roads is a good course of action and fulfills the requirements set forth in NAC Chapter 513.330 - 513.360.

5-6 One minor correction should be made in the text: The Nevada Department of Minerals is now known as the Nevada Division of Minerals (a division within the Department of Business and Industry).

5-7 The measures cited to protect birds and small animals from solution pond access adequately address the problem.

5-8 The revegetation plans discussed in the reclamation sections of the DEIS will provide for healthy plant communities of much better quality than currently exist on surrounding undisturbed lands, especially the weed-infested areas damaged by past wildfires. The post-mining reclaimed and revegetated lands will provide good forage for grazing and good protection and food sources for a wide variety of wildlife.

We look forward to reviewing the final EIS once it becomes available.

Please contact Division staff at any time for additional information or assistance.

Sincerely,

Bill Durbin

Bill Durbin - Chief
Abandoned Mine Lands Program

bd\sa197003

Response to Letter 5

inhibiting future access to additional mineralization, as well as manpower and equipment costs. The amount of fuel consumption and dust generation associated with this alternative would be lower than the impacts associated with the Proposed Action due to a shorter haul distance.

5-5 Comment noted.

5-6 The Final EIS has been revised to reflect this change.

5-7 Comment noted.

5-8 Comment noted.

Letter 6

Nevada Natural Heritage Program

Department of Conservation and Natural Resources
1550 East College Parkway, suite 145 * Carson City, Nevada 89710
(702) 687-4245

20 August 1996

Comments on Nevada SAI # E1997-003: **Draft EIS - Twin Creeks Mine**
Comment due date August 26, 1996.

6-1 We disagree with the assumption in section 3.4 of the DEIS that simply because certain weed species do not appear in the State's Administrative Code as Noxious or Injurious, they are therefore not noxious or injurious, and that increases in their cover do not represent significant impacts. Cheatgrass (*Bromus tectorum*), russian thistle (*Salsola iberica* and other species), and hornseed buttercup (*Ranunculus testiculatus*) are all aggressively invasive foreign weeds that are increasingly degrading and often completely replacing the native, more diverse and productive vegetation of Nevada. The acknowledged likelihood that covers of these species will increase as a result of the project should be addressed as a significant and cumulative impact.

6-2 We also disagree with the statement on page 3-143 that the project "is not expected to increase the potential for noxious weed establishment," even as narrowly defined by the State. Even if no Noxious Weed species presently exist in the project area to provide a seed source, the potential for establishment will still been increased by virtue of creating new disturbances available for colonization. Any inadvertent transport of seeds from off site (on vehicle tires, employee clothing or shoes, transient animals, fill material, etc.) could easily result in actual establishment of new noxious weed species once the disturbance has been created. Monitoring and mitigation should therefore include monitoring for establishment of new exotic weed species (whether or not on the State's official list) and aggressive elimination of any new infestations.

6-3 The proponent and BLM should make every effort to find reclamation seed mixes composed of only 100% native plant species for achieving reclamation goals. More companies specializing in native seed are stocking more native species all the time, and there should no longer be any need to further permanently alter the State's native vegetation by intentionally introducing exotic species to achieve reclamation goals. The proposed seed mixes on page 2-42 (Tables 2-7 and 2-8) contain unacceptable levels of exotic species. The final proposed list of species available for reclamation use should be published as part of the EIS using both scientific and common names. We commend the preparers for using both scientific and common names in the DEIS.

Response to Letter 6

6-1 Noxious weeds (as defined in the Nevada Administrative Code) were considered under a separate significance criterion (page 3-135 of the Draft EIS) because they represented a distinct group of species with legal ramifications related to control procedures and reclamation seed sources. Noxious weeds have not been an issue on existing reclaimed areas, and with the continued use of noxious weed-free seed sources by SFPG, the BLM expects the potential for invasion and spread of these species on the reclaimed area to be relatively low. The invasion and spread of other aggressive weedy species already common in the vicinity is much more likely, unless desirable plant species are promptly established to provide effective competition. This potential for invasion of weedy species is recognized and discussed in the Draft EIS. A separate significance criterion was not assigned to this potential problem since it would be redundant with the other criteria, which include "failure of reclamation efforts to achieve a stable, perennial vegetation cover that protects disturbed soil surfaces against erosion," and "establishment of vegetation communities on the reclaimed areas that fail to meet the reclamation objectives of providing suitable forage for livestock and wildlife." The BLM does not agree that any measurable increase in these common weedy species should be considered a significant impact.

6-2 The BLM agrees that an increase in the disturbed surface area would increase the potential for invasion of noxious weed species, although this potential is considered low. Mitigation measure V-2 has been added in Section 3.4.4 of the Final EIS wherein SFPG would monitor the presence of noxious weed species as part of the reclamation monitoring program. If such species are found, appropriate control measures would be implemented.

6-3 Please refer to the response to comment 2-2 regarding the use of native plant species.

Letter 7

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
1263 S. Stewart Street
Carson City, Nevada 89712

BOB MILLER, Governor

TOM STEPHENS, P.E., Director

July 31, 1996

In Reply Refer to

Julie Butler, Coordinator
Nevada State Clearinghouse
Department of Administration
Budget Division
Blasdel Building, Room 204
Carson City, NV 89701

PSD 7.01

Dear Ms. Butler:

The Nevada Department of Transportation has reviewed the project titled Draft EIS - Twin Creeks Mine SAI#E1997-003

Based on the information submitted, we have the following comments on the proposed project.

7-1 A traffic study will be needed concerning impact on SR 789 (Midas Road). An analysis of the same traffic study concerning structural section of SR 789 roadway will also be needed.

Thank you for the opportunity to review this project.

Sincerely,

Thomas J. Fronapfel

Thomas J. Fronapfel, P.E.
Assistant Director - Planning

TJF:PAF:dg

Response to Letter 7

7-1 SFPG retained the services of Nichols Consulting Engineers, Chtd. to evaluate the potential impacts to the existing pavement on State Route 789 from seven different traffic loadings associated with the Twin Creeks Mine. Based on these findings, Nichols developed overlay thickness designs as potential mitigation. The study included State Route 789 from the Golconda exit on Interstate 80 to the end of the existing pavement, approximately 16 miles to the northeast.

To characterize the condition of the existing pavement, a field investigation was completed that included material sampling and nondestructive deflection testing. For the material sampling, borings were drilled at 32 locations along State Route 789 to determine the thickness of the pavement and road base and to characterize the subgrade soil types. Deflection tests were performed in the outer wheelpath in each lane and were measured at 9,000 and 10,000 pounds. The deflection test data were analyzed to characterize the existing pavement structural capacity and integrity and to determine the subgrade soil modulus required for the pavement overlay thickness design.

SFPG provided traffic data for a 15-year design period for the following 7 traffic load conditions (it was assumed that the ore trucks were loaded only in the northbound direction [going to the Twin Creeks Mine]):

1. Existing traffic (northbound)
2. All traffic - no Rosebud Mine ore trucks (northbound)
3. Existing traffic plus 50 percent of all vendor trucks - no ore trucks (northbound)
4. All traffic (northbound)
5. Existing traffic plus 50 percent of all vendor trucks plus Rosebud Mine ore trucks (northbound)
6. Existing traffic plus 100 percent of all vendor trucks - no ore trucks (northbound)
7. All traffic (southbound)

The pavement overlay design was completed using the Mechanistic Overlay Design Procedure developed for the State of Nevada Department of Transportation by Dr. Sebaaly at the University of Nevada (August 1992). The results of the analysis indicated a range of alternative pavement overlay thicknesses between 2 and 7 inches. Mitigation measure LU-1 was added to Section 3.10.4 of the Final EIS. This mitigation measure describes SFPG coordination with the Nevada Department of Transportation to implement a resolution regarding the pavement overlay needs for State Route 789 between the Golconda exit and the end of the existing pavement.

Letter 8

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
P.O. Box 3267
Winnemucca, Nevada 89446
(702) 623-8000

BOB MILLER, *Governor*

TOM STEPHENS, P.E., *Director*

August 22, 1996

RE: 1793/3809
(NV-932.8)
(NV-020)

United States Department of the Interior
Bureau of Land Management
Winnemucca District Office
5100 East Winnemucca Boulevard
Winnemucca, Nevada 89445
Ron Wenker, District Manager

Attention: Gerald Moritz, EIS Project Manager

Dear Mr. Moritz,

The Winnemucca Office of the Department Of Transportation has reviewed the Draft Environmental Impact Statement for SFPG's Final BLM Plan of Operations, NDEP Reclamation Plan and Permit Application for the Twin Creeks Mine.

NDOT's sole concern for this project, as with all others, is the impact of each action on Nevada's Highway System. The Draft EIS, Section 3-10, discussed a temporary impact to the access routes resulting from the construction activities. Also mentioned are the increased foreseeable truck loadings. Although the volumes will not exceed the route capacities, we expect to see an increased deterioration primarily on SR 789 (Getchel Road). These loads are the destructive forces acting on our roadways. The EIS indicates an additional 75 loads per day, but does not address the potential for processing growth or capabilities, which would increase truck traffic without necessitating a mine expansion. **8-1**

Also, not addressed is current conditions of the roadway surfaces and the expected degradation resulting from the impact of the mine activities. NDOT will require a traffic study, engineering analysis and course of action to mitigate the affects of the mine traffic on State Route 789. Until such time as these issues are addressed, NDOT must voice its objections to the expansion and permit application for the SFPG's Twin Creeks Mine. **8-2**

If I can answer any questions regarding SR 789 or NDOT's concerns with the Draft EIS for S.F.P.G., please feel free to call me at 702-623-8000.

Sincerely,

Mike J. Glock,
Assistant District Engineer

MJG/ls

PC: Chris Beck, District Engineer

Response to Letter 8

8-1 The analyses conducted for the EIS and the pavement evaluation of State Route 789 included SFPG's most reasonable projections of anticipated processing demand at the Twin Creeks Mine based on known ore production, including the importation of material from the Mule Canyon, Lone Tree, and Rosebud mines. No additional growth in processing demand at the Twin Creeks Mine is being forecast at this time above the volume evaluated in the EIS and the State Route 789 pavement study.

8-2 Please see the response to comment 7-1.

Letter 8A

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
1263 S. Stewart Street
Carson City, Nevada 89712

BOB MILLER, *Governor*

TOM STEPHENS, P.E., *Director*

September 25, 1996

In Reply Refer to:

RECEIVED OCT 0 7 1996

Ron Wenker, District Manager
United States Department of the Interior
Bureau of Land Management
Winnemucca District Office
5100 East Winnemucca Boulevard
Winnemucca, Nevada 89445

PSD 1 06

Attention: Gerald Moritz, EIS Project Manager

Dear Mr. Moritz:

8A-1 The Department of Transportation hereby withdraws its August 22, 1996 objection to the expansion of and permit application for the Santa Fe Pacific Gold Twin Creeks Mine. However, the traffic study and engineering analysis must still be completed as requested. In addition, the Department formally requests that they be included as part of the Final EIS, as well as any comments we have following our review of them. Any necessary actions required of Santa Fe Pacific Gold to mitigate the effects on the Department's roadway system are outside the EIS process and will be determined by the Department.

Thank you for your prompt attention to this matter.

Sincerely,

Thomas J. Fronapfel

Thomas J. Fronapfel, P.E.
Assistant Director, Planning

TJF/dm

cc: Russ Fields, Division of Minerals
John Young, Santa Fe Pacific Gold
Mike Glock, NDOT
Chris Beck, NDOT
Julie Butler, State Clearinghouse

Response to Letter 8A

8A-1 The traffic and engineering study requested by the Nevada Department of Transportation has been completed; please see the response to comment 7-1. The Nevada Department of Transportation has reviewed the results of the study and indicated the recommendations appear adequate.

Letter 9

BOB MILLER
Governor

STATE OF NEVADA

PETER G. MORROS
Director

R. MICHAEL TURNIPSEED, P.E.
State Engineer

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
Capitol Complex
123 W. Nye Lane
Carson City, Nevada 89710
(702) 687-4380

August 26, 1996

Nevada State Clearinghouse
Dept of Administration
Planning Division
Blasdel Bldg Room 202
Carson City NV 89710

RE: Nevada SAI# E1997-003 Due Date: August 26, 1996

Dear Gentlemen,

9-1 Pages x and xi of the summary mention land subsidence. A discussion of the subsidence and its impact on groundwater storage should be included in Section 3.2 and 3.17.

9-2 Allowing the pit to fill with groundwater at mine closure and the attendant evaporation will constitute a permanent appropriation of the underground waters of the State of Nevada. The evaporation will be water lost from development to beneficial use. An analysis of post-mining groundwater discharge -vs- pre-mining discharge (i.e. pit lake evaporation -vs- pheatophytes etc.) would be appropriate.

9-3 Santa Fe Pacific Gold Corporation currently holds dam safety permits for those structures mentioned in the "no action" alternative J-327, Pinion Tailings Dam and J-429, Juniper Tailings Dam. SFPG also holds dam safety permits for other, smaller ponds at the site for various purposes. The most recent water permits issued to SFPG allow pumping at a rate not to exceed 30.75 cfs (13800 gpm) but no more than 6121 AF annually.

AUG 27 1996

Sincerely,

Michael J. Anderson, P.E.
Hydraulic Engineer III

MJA/tdf

Response to Letter 9

9-1 A discussion of potential changes in storage resulting from subsidence induced by ground water withdrawal has been added to Section 3.2 of the Final EIS.

9-2 The estimated changes in the annual ground water budget for the hydrographic study area have been added to Section 3.2.3 of the Final EIS. The budget estimate includes the changes in total discharge from pit lake evaporation and evapotranspiration from phreatophytes.

9-3 Comment noted.

Letter 10

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF WILDLIFE

1100 Valley Road
P.O. Box 10678
Reno, Nevada 89520-0022
(702) 688-1500 • Fax (702) 688-1595

PETER G. MORROS
Director
Department of Conservation and Natural Resources

WILLIAM A. MOLINI
Administrator

BOB MILLER
Governor

AUG 14 1996
DISTRICT OFFICE
WINNEMUCCA NEVADA

Nevada Division of Wildlife
Region 1 Ph 422-3171
380 West B Street
Fallon, Nevada 89406

August 6, 1996

Nevada State Clearinghouse
Department of Administration
Budget and Planning Division
Blasdel Building, Room 200
Carson City, Nevada 89710
Attn: Terri Rodefer

Re: DEIS Twin Creeks Mine - SAI#E1997-003, due August 26, 1996

Dear Terri,

10-1 Thank you for allowing us to review the Twin Creeks Mine DEIS. We are seriously concerned about the document's estimate of a 19 percent reduction in flows for the Little Humboldt River over a 100-year period (both alternatives) and a potential loss of upper basin aspen habitat on the west side of the Snowstorms (proposed alternative). Potential losses in wildlife values could be acute with respect to certain neotropical migrants, including: bobolink; yellow-breasted chat; willow flycatcher; Swainson's hawk. Both long-eared owls and short-eared owls are prominent breeders along the Little Humboldt, and could be negatively affected if willows, buffaloberry, or haymeadows are negatively impacted by dewatering. A ten- or twelve-year habitat potential reduction could be weathered -- a 100-year degradation could not. The Little Humboldt and Paradise Valley provide biodiversity components to the region which could not be replaced. Critical habitats include the Little Humboldt Ranch, the Bullhead Ranch, 4R Ranch , Bar U Ranch (Thomas), and the Circle A properties extending south to the Godchaux Ranch.

Monitoring programs must be established for habitat quality along the Little Humboldt, not only including willow, buffaloberry, and haymeadow monitoring, but bird population monitoring as well. Mitigation measures, if warranted as a result of monitoring, should concentrate on maintaining the critical habitats on the above named properties. Possible lines of attack might include upgrading of existing water management systems, development of alternative water

10-5386

Response to Letter 10

10-1 Mitigation measure TW-3 in the Draft EIS inferred that a monitoring program would be established following the baseline inventories of the applicable seeps, springs, and perennial drainages (e.g., Little Humboldt River). A monitoring program would be implemented in order to determine whether any significant impacts to water resources were occurring because of mining operations and dewatering activities. In coordination with the applicable federal and state agencies, the extent of potential impacts would be used to determine the level of mitigation necessary. Based on this comment, the mitigation measure has been clarified relative to the Little Humboldt River and the implementation of an adequate monitoring program for potential ground water and surface water impacts. TW-3 in Section 3.5.4 of the Draft and Final EIS addresses off-site mitigation for potential terrestrial and aquatic habitat losses from ground water drawdown.

Letter 10 Continued

Ms. Terri Rodefer
August 6, 1996
Page Two

sources (i.e. Martin Creek, Cottonwood Creek, new wells, etc.), or fencing of critical riparian habitats and groundwater sources. This would all be contingent on private landowner cooperation, of course.

Our suggested mitigation strategy for the Little Humboldt would be:

10-1 1) Establish a monitoring program for the wildlife and habitats associated with the Little Humboldt.

2) Establish habitat degradation thresholds which, if attained, would trigger habitat conservation contingencies.

3) Develop habitat conservation contingencies through the cooperation of Santa Fe Pacific Gold, the landowners of the affected floodplain, and Nevada Division of Wildlife.

10-2 Our suggestion for creating the framework within which mitigation strategies for the Little Humboldt River would develop would be for Santa Fe Pacific Gold to become involved as a corporate partner in the Partners In Flight Nevada Working Group. The PIF Working Group is a consortium of federal land agencies, state and federal wildlife agencies, the University of Nevada, and Nevada conservation groups that are formulating conservation strategies and monitoring plans for Nevada's neotropical migrant bird species. The Working Group is modeled after a National PIF effort, a Western States effort, and many other state working groups all operating under the national and western umbrella. The Nevada Working Group is looking to set monitoring and conservation priorities, then coordinate the various funding sources into an organized statewide effort with achieveable, accountable goals. Because of the unique values of the Little Humboldt system, it would almost certainly shake out as a high priority for monitoring, research, and habitat conservation projects. Santa Fe Pacific Gold could play a valuable role in putting those projects on the ground while satisfying its mitigation responsibilities in the process.

10-3 We wish to express our concern for the long-term water quality of the pit lake which will establish after cessation of mining activities. We are concerned about the persistent exposure of wildlife to poor quality water which may adversely affect wildlife through heavy metal contamination and accumulation. We do not necessarily agree that sheer pit walls will be sufficient to deter mule deer from being exposed to the pit lake water. Migratory and wintering bald eagles may not find fish in the lake, but could be

Response to Letter 10

10-2 Comment noted. SFPG is currently considering participating in the Partners in Flight program; however, this effort would occur outside of the National Environmental Policy Act process.

10-3 The first paragraph in Section 3.5.4.1 of the Draft EIS refers to Section 3.2.4 and states that SFPG would monitor pit lake water quality during mine reclamation and closure, and it would be responsible for reporting all wildlife mortalities to the applicable agencies. Also, please see the response to comment 2-14 regarding pit lake water quality and the responses to comments 1-36, 1-40, and 2-1 regarding the development and implementation of applicable mitigation and monitoring measures for this project.

Response to Letter 10

The ecological risk assessment presented in Appendix C of the Draft EIS examined a number of habitat variables and exposure pathways for potential bioaccumulation of certain chemicals of concern in terrestrial wildlife species that may use the future pit lake. Please see the response to comment 1-54 and Attachment C1 to Appendix C of the Final EIS for a more detailed explanation of the assumptions and processes used for both the screening-level risk assessment and the baseline risk assessment. The risk assessment results indicated that none of the receptors were predicted to be at risk from either acute or chronic exposure in the future pit lake scenarios.

The mule deer was originally selected as a receptor species to represent big game animals in the project area. The exposure characterization revealed that the availability of alternative drinking water sources during fall, winter, and spring seasons would minimize potential deer use of the pit lake water, particularly since the steep pit walls would present a much more difficult path to water than that provided in surrounding stock ponds and naturally occurring drainages (e.g., Kelly Creek and Rabbit Creek). In addition, during the summer period when available water is the most limited and free water demands are the greatest for deer, the majority of the resident animals would be expected to move into the higher elevations of the Osgood and Snowstorm mountains where microclimates are more favorable, summer forbs are still available, and water sources are more available, further preventing their exposure to the future pit lake. Although an individual deer may occasionally navigate the steep pit walls to access pit lake water, it is not anticipated that the general population of mule deer would regularly use the pit lake. Thus, exposure of individual mule deer would not translate into population-level effects. As discussed in the response to comment 1-54, the ecological risk assessment evaluates risks to populations and not individual wildlife. Consequently, no exposure pathway exists for mule deer <u>populations</u> in the future pit lake.

The conceptual model developed for the ecological risk assessment also indicated that wintering and migrating bald eagles would not likely be exposed to the future pit lake. The lack of foraging habitat combined with the availability of higher quality foraging habitat nearby at Chimney Reservoir and along the Humboldt River led to the conclusion that bald eagles would not use the pit lake as a foraging site. Although it cannot be ruled out that individual bald eagles may be acutely exposed by drinking water from the future pit lake for a single day some time during their lifetime, the absence of resident prey populations, such as fish or resident ducks (Parametrix 1996) would prevent chronic exposure of individual bald eagles to the future pit lake.

Letter 10 Continued

Ms. Terri Rodefer
August 6, 1996
Page Three

exposed to the water regardless. We also failed to find mitigation measures proposed in the document for the chronic exposure of flight-feeding birds (swallows, nighthawks, swifts), bats, and migratory aquatic birds to the poor pit lake water.

Our suggested mitigation strategy for pit lake concerns would include:

10-3 1) Monitor the potential for wildlife mortalities associated with the pit lake after cessation of mining activities.

2) Monitor bioaccumulation of pit lake contaminants in species determined to be particularly at risk.

3) Develop contingencies to address problems associated with pit lake biocontamination should they be found to be significant.

10-4 We agree with the document's mitigation strategies concerning dewatering impacts to the area's naturally-occurring seeps, springs and perennial drainages.

Sincerely,

WILLIAM A. MOLINI, ADMINISTRATOR

Richard T. Heap, Jr.
Regional Manager
Region I

JLG/ln
CC: Winnemucca BLM - Gerald Moritz
NDOW field office - Winnemucca
Habitat Bureau - Reno
NDEP - Bureau of Mining Regulation and Reclamation

Response to Letter 10

In response to the comment and the Nevada Division of Wildlife's concern regarding the bald eagle's potential exposure to future pit water, the acute exposure of individual eagles via a drinking water pathway was subsequently assessed in the Final EIS for each lake scenario (the No Action and Proposed Action pit lakes for 5 years, 27 years, and equilibrium). This analysis and supporting data are presented in Attachment C2 to Appendix C of the Final EIS. As indicated in this attachment, no risk to either wintering or migrating bald eagles has been identified.

Because no acute or chronic effects have been identified for either mule deer or bald eagles from potential isolated exposure to future pit lake water, no mitigation strategies have been developed.

10-4 Comment noted.

Letter 10 Continued

NEVADA STATE CLEARINGHOUSE
Department of Administration
Budget and Planning Division
Blasdel Bldg., Rm. 200
(702) 687-4065
fax (702) 687-3983

JUL 1996

DATE: July 3, 1996

Governor's Office	Legislative Counsel Bureau	Conservation-Natural Resources
Nuclear Projects Office	Communications Bd.	**Director's Office**
Business & Industry	Emp. Training & Rehab.	**State Lands**
Agriculture	Research Division	**Environmental Protection**
Energy	PSC	Forestry
Minerals	**Transportation**	**Wildlife**
Economic Development	**UNR Bureau of Mines**	**Region 1** ✓
Tourism	**UNR Library**	Region 2
Fire Marshal	UNLV Library	Region 3
Human Resources	**Wild Horse Commission**	Conservation Districts
Aging Services	**Historic Preservation**	State Parks
Health Division	Emergency Management	**Water Resources**
Colorado River Commission	Washington Office	Water Planning
Indian Commission		**Natural Heritage**

Nevada SAI # E1997-003 **Project: Draft EIS – Twin Creeks Mine**

__ Yes	__ No	**Send more information on this project as it becomes available.**

CLEARINGHOUSE NOTES:
Related SAI # 95300011.

Enclosed, for your review and comment, is a copy of the above mentioned project. Please evaluate it with respect to its effect on your plans and programs; the importance of its contribution to state and/or local areawide goals and objectives; and its accord with any applicable laws, orders or regulations with which you are familiar.

Please submit your comments no later than **August 26, 1996**. Use the space below for short comments. If significant comments are provided, please use agency letterhead and include the Nevada SAI number and comment due date for our reference. If you have any questions, please contact Terri Rodefer, Clearinghouse Environmental Advocate, at 687-6382, or Julie Butler, Clearinghouse Coordinator, 687-6367.

THIS SECTION TO BE COMPLETED BY REVIEW AGENCY:

____No comment on this project	____Conference desired (See below)
____Proposal supported as written	____Conditional support (See below)
____Additional information below	____Disapproval (Explain below)

AGENCY COMMENTS: See attached letter.

7

Letter 11

SIERRA CLUB

Toiyabe Chapter – Nevada and Eastern California

Sept. 1, 1996

Bureau of Land Management
Attn: Gerald Morits, EIS Project Manager
Winnemucca District Office
705 E. 4th St.
Winnemucca, NV 89445

RE: TWIN CREEKS MINE DRAFT ENVIRONMENTAL IMPACT STATEMENT

Dear Mr. Morits:

The following comments are submitted on behalf of Great Basin Mine Watch and the Toiyabe Chapter of the Sierra Club. These groups have substantial concerns regarding the adequacy of the Twin Creeks Mine Draft Environmental Impact Statement and, we offer the following comments:

1. **Compliance with the National Environmental Policy Act**

The Draft Environmental Impact Statement (DEIS) for the Twin Creeks Mine of Santa Fe does not meet the intent or requirements of the National Environmental Policy Act (NEPA).

1. The EIS does not consider in detail any alternatives, as required in NEPA. Section 102(2) (E) of NEPA requires federal agencies to

> "study, develop and describe appropriate alternatives to recommended courses of action in any proposal which involved unresolved conflicts concerning alternative uses of available resources." 42 U.S.C. 4332 (2) (E).

11-1

The CEQ regulations (40 CFR 1502.14) refer to this requirement as the "heart of the environmental impact statement" and demand that agencies "rigorously explore and objectively evaluate all reasonable alternatives" and "devote substantial treatment to each alternative considered. . . so that reviewers may evaluate their comparative merits." This EIS considers only the proposed action in detail, and includes the strawman "no action" alternative. Only relatively trivial options were considered as alternatives, and other reasonable and practical alternatives which could substantially decrease the impacts were

Response to Letter 11

11-1 As stated in this comment and in the Council on Environmental Quality guidelines for implementing the National Environmental Policy Act (40 Code of Federal Regulations 1500), alternatives are the "heart of the environmental impact statement." For the Twin Creeks Mine EIS, alternatives have been identified and evaluated throughout the National Environmental Policy Act process.

As described in Section 2.5.1 of the Draft EIS, multiple alternatives are addressed in detail, including the No Action alternative, a partial pit backfill alternative, an alternative waste management procedure, and reclamation alternatives. These alternatives were selected in response to the environmental issues raised during the scoping process, including potential water quality impacts associated with the overburden and interburden piles and reclamation issues.

These alternatives were initially reviewed to determine their potential to provide an environmental advantage over the Proposed Action. If a potential environmental improvement was not identified, the alternative was included in the "considered but eliminated" category; the alternatives in this category and the associated rationale for this classification are identified in Section 2.5.2 of the Draft EIS.

Two additional alternatives were examined in the Final EIS in response to comments received on the Draft EIS relative to the Shoshone Mike Massacre site (West Side alternative) and impacts

Letter 11 Continued

11-1 not rigorously considered. Other alternatives were mentioned, but discarded after a brief discussion.

11-2 This project will have a substantial impact on the surrounding groundwater system. Refilling the main pit was not given serious attention. That alternative, although admittedly costly, is credible. Refilling a portion of the original pit is also a potential alternative. Refilling to the water line would reduce the water deficit created by the pit by over 460,000 acre-feet and should have been considered. Because of potential groundwater problems from poor pit lake water quality, this alternative may ultimately be required. The "loss of mineral resources" argument is effectively without merit. Once the pit fills with water, that water will almost certainly not meet discharge standards and will require treatment prior to discharge to remove salts and other contaminants, including antimony and arsenic. The costs of that treatment may well exceed the costs of remining rock placed back into the pit and, thus, it is conceivably a greater "loss of mineral resources" to allow the pit to refill.

11-3 Another option is to allow the pit to be excavated, but require a clearly detailed plan and commitment to treat the water in the pit until it meets water quality standards to protect aquatic life. The lake could then be potentially used as a fishery or for other forms of recreation. To leave it in the contaminated state will be a cost to future generations for the foreseeable future. The BLM has the clear authority to prohibit creation of a useless and contaminated body of water on public lands, and to not even consider this alternative is a waste of a critical resource in Nevada. Based on the environmental documents we have reviewed to date, this mine will create the single largest man-made lake completely in Nevada. With additional thought, other methods of mining and remediation are clearly available. One example is refilling the pit (or either portions of the north or south pit with sufficient organic substrate to allow sulfate reducing processes to precipitate the metals as sulfide. Additional research would be needed to demonstrate the success of this alternative, but it clearly could be accomplished. These alternatives, or a combination of alternatives, are reasonable and although some may introduce additional costs, the BLM has the responsibility and authority to protect other public values. Those alternatives, or a combination of alternatives, can be used to substantially reduce the impacts of this mine, but were dismissed with only a very brief discussion.

11-4 Because no analysis of alternatives was conducted, the BLM is left with no decision to make. This document violates NEPA and should be rewritten from the beginning.

11-5 The BLM has not performed a cumulative impact analysis of this action and past, present and likely future actions, on the Humboldt River Basin. The impacts of this mine on the Humboldt River need to be assessed in relation to other mines in the Basin. Until this analysis has been completed, or at least funded and initiated, no mine expansions which affect significant amounts of water in the Humboldt River should be permitted. The Sierra Club has argued for an *independent* major cumulative impacts analysis of mine dewatering along the Humboldt River for several years, yet none has been completed, and

Response to Letter 11

associated with the proposed Rabbit Creek Diversion (East Side alternative).

11-2 SFPG has estimated the costs to backfill the South Pit to the premining water level in order to eliminate a pit lake. SFPG estimates that approximately 1.3 billion tons of overburden and interburden material would be required to backfill the pit to an elevation of 4,700 feet. At a backfilling rate of 59.1 million tons per year, it would take approximately 23 years to backfill the pit. The backfilling costs would average $0.33 per ton, for a total cost of approximately $427,273,000 over the 23-year period. The backfilling rate assumes the use of the existing equipment, consisting of shovels, haul trucks, dozers, and graders; the costs would increase for the purchase of additional equipment to backfill the pit at a faster rate. The assumptions for the cost estimate are shown in Table F-2.

In addition to the economic impact, there would be environmental impacts associated with the pit backfilling, which are described in Section 2.5.2 of the Final EIS.

11-3 Please see the response to comment 2-14 regarding the pit water quality analysis and monitoring requirements. As explained in that response, the results of the pit lake water quality study and the ecological risk assessment indicated that no significant adverse impacts are anticipated from the pit lake. Therefore, no mitigation measures or alternatives are considered necessary.

11-4 The range of alternatives analyzed in the Draft and Final EIS and discussed in the response to comment 11-1 provided the BLM with a choice of mine rock handling methods, reclamation options, and storm water control options. In addition, the BLM will stipulate the final monitoring and mitigation to be implemented in the Record of Decision. As an example, the Agency Preferred alternative in the Draft EIS included Reclamation Alternative 2 and the alternative of partially backfilling the Vista Pit in combination with the Proposed Action.

11-5 A statement under the heading "Impacts to Perennial Streams and Springs" in Sections 3.2.2.2 (No Action) and 3.2.2.3 (Proposed Action) of the Final EIS has been added to indicate that a reduction in the baseflow of the Humboldt River in the hydrologic study area is not predicted. SFPG has already voluntarily contributed funds for a study of the cumulative impacts to the Humboldt River. Since the Twin Creeks Mine is not predicted to have a significant impact to flows in the Humboldt River, no mitigation measures (such as funding additional studies of the cumulative impacts to the Humboldt) are warranted.

TABLE F-2
Cost To Backfill South Pit To Original Water Table

	Units	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12
SHOVELS													
P&H 4100													
Production	tons/yr	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000
Productivity	tons/op hr	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Eff. Utilization		75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Operating Hours	op.hr/yr	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570
Cost/hr	$/hr	275	275	275	275	275	275	275	275	275	275	275	275
Total Cost	**$/yr**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**
P&H 2800													
Production	tons/yr	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000
Productivity	tons/op hr	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Eff. Utilization		75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Operating Hours	op.hr/yr	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570
Cost/hr	$/hr	250	250	250	250	250	250	250	250	250	250	250	250
Total Cost	**$/yr**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**
TRUCKS													
Payload	dry tons	230	230	230	230	230	230	230	230	230	230	230	230
Cycle Time	min/trip	27.2	27.2	27.2	27.2	27.2	23	23	23	23	23	20.9	20.9
Op Hrs/yr	hr/yr	139,855	139,855	139,855	139,855	139,855	118,260	118,260	118,260	118,260	118,260	107,462	107,462
Effective Utilization		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
# Trucks Req'd	#	26.6	26.6	26.6	26.6	26.6	22.5	22.5	22.5	22.5	22.5	20.4	20.4
Cost/hr	$/hr	110	110	110	110	110	110	110	110	110	110	110	110
Total Cost	**$/yr**	**$ 15,384,083**	**$ 15,384,083**	**$ 15,384,083**	**$ 15,384,083**	**$ 15,384,083**	**$ 13,008,600**	**$ 13,008,600**	**$ 13,008,600**	**$ 13,008,600**	**$ 13,008,600**	**$ 11,820,858**	**$ 11,820,858**
DOZERS													
# Required	#	3	3	3	3	3	3	3	3	3	3	3	3
Effective Utilization		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Op Hrs/yr	hr/yr	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768
Cost/hr	$/hr	82	82	82	82	82	82	82	82	82	82	82	82
Total Cost	**$/yr**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**
GRADERS													
# Required	#	2	2	2	2	2	2	2	2	2	2	2	2
Effective Utilization		30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Op Hrs/yr	hr/yr	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256
Cost/hr	$/hr	42	42	42	42	42	42	42	42	42	42	42	42
Total Cost	**$/yr**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**
DEWATERING													
Pumping Rate	gal/min	12,000	10,000	8,000	6,000	4,000	-	-	-	-	-	-	-
Unit Cost	$/gpm/yr	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total Cost	**$/yr**	**$ 12,000,000**	**$ 10,000,000**	**$ 8,000,000**	**$ 6,000,000**	**$ 4,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
SUMMARY													
Total Production	tons/yr	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000
Tons Remaining	tons	1,245,881,000	1,186,751,000	1,127,621,000	1,068,491,000	1,009,361,000	950,231,000	891,101,000	831,971,000	772,841,000	713,711,000	654,581,000	595,451,000
Total Costs	**$/yr**	**$ 32,347,061**	**$ 30,347,061**	**$ 28,347,061**	**$ 26,347,061**	**$ 24,347,061**	**$ 17,971,578**	**$ 17,971,578**	**$ 17,971,578**	**$ 17,971,578**	**$ 17,971,578**	**$ 16,783,836**	**$ 16,783,836**
Cost per Ton	$/ton	0.55	0.51	0.48	0.45	0.41	0.30	0.30	0.30	0.30	0.30	0.28	0.28

Source:
Santa Fe Pacific Gold Corporation

TABLE F-2
Cost To Backfill South Pit To Original Water Table

	Units	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20	YEAR 21	YEAR 22	YEAR 23	TOTAL
SHOVELS													
P&H 4100													
Production	tons/yr	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	32,850,000	4,380,000	727,080,000
Productivity	tons/op hr	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Eff. Utilization		75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	10%	72%
Operating Hours	op.hr/yr	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	876	6,322
Cost/hr	$/hr	275	275	275	275	275	275	275	275	275	275	275	275
Total Cost	**$/yr**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 1,806,750**	**$ 240,900**	**$ 39,989,400**
P&H 2800													
Production	tons/yr	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	26,280,000	-	578,160,000
Productivity	tons/op hr	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Eff. Utilization		75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	0%	72%
Operating Hours	op.hr/yr	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	6,570	-	6,284
Cost/hr	$/hr	250	250	250	250	250	250	250	250	250	250	250	250
Total Cost	**$/yr**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ 1,642,500**	**$ -**	**$ 36,135,000**
TRUCKS													
Payload	dry tons	230	230	230	230	230	230	230	230	230	230	230	230
Cycle Time	min/trip	20.9	20.9	20.9	19.4	19.4	19.4	19.4	19.4	18.6	18.6	18.6	22.1
Op Hrs/yr	hr/yr	107,462	107,462	107,462	99,750	99,750	99,750	99,750	99,750	95,636	95,636	7,084	109,782
Effective Utilization		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
# Trucks Req'd	#	20.4	20.4	20.4	19.0	19.0	19.0	19.0	19.0	18.2	18.2	1.3	20.9
Cost/hr	$/hr	110	110	110	110	110	110	110	110	110	110	110	110
Total Cost	**$/yr**	**$ 11,820,858**	**$ 11,820,858**	**$ 11,820,858**	**$ 10,972,471**	**$ 10,972,471**	**$ 10,972,471**	**$ 10,972,471**	**$ 10,972,471**	**$ 10,519,998**	**$ 10,519,998**	**$ 779,259**	**$ 277,749,321**
DOZERS													
# Required	#	3	3	3	3	3	3	3	3	3	3	2	3
Effective Utilization		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	6%	58%
Op Hrs/yr	hr/yr	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	15,768	1,051	15,128
Cost/hr	$/hr	82	82	82	82	82	82	82	82	82	82	82	82
Total Cost	**$/yr**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 1,292,976**	**$ 86,198**	**$ 28,531,670**
GRADERS													
# Required	#	2	2	2	2	2	2	2	2	2	2	1	2
Effective Utilization		30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	3%	29%
Op Hrs/yr	hr/yr	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	5,256	263	5,039
Cost/hr	$/hr	42	42	42	42	42	42	42	42	42	42	42	42
Total Cost	**$/yr**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 220,752**	**$ 11,038**	**$ 4,867,582**
DEWATERING													
Pumping Rate	gal/min	-	-	-	-	-	-	-	-	-	-	-	1,739
Unit Cost	$/gpm/yr	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total Cost	**$/yr**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 40,000,000**
SUMMARY													
Total Production	tons/yr	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	59,130,000	4,380,000	1,305,240,000
Tons Remaining	tons	536,321,000	477,191,000	418,061,000	358,931,000	299,801,000	240,671,000	181,541,000	122,411,000	63,281,000	4,151,000	(229,000)	
Total Costs	**$/yr**	**$ 16,783,836**	**$ 16,783,836**	**$ 16,783,836**	**$ 15,935,449**	**$ 15,935,449**	**$ 15,935,449**	**$ 15,935,449**	**$ 15,935,449**	**$ 15,482,976**	**$ 15,482,976**	**$ 1,117,395**	**$ 427,272,973**
Cost per Ton	$/ton	0.28	0.28	0.28	0.27	0.27	0.27	0.27	0.27	0.26	0.26	0.26	0.33

Source:
Santa Fe Pacific Gold Corporation

Letter 11 Continued

11-5 the present meager funding for a superficial study (approximately $650,000) is far from being sufficient. An adequate study will cost at least five million dollars over five years. Because of the large impacts from the Twin Creeks and Lone Tree mines, this company should be responsible for funding a majority of that study. The Twin Creeks mine should not be permitted until those funds are committed. An important aspect of mitigation is understanding the problem, and the cumulative water deficit in the Humboldt River is not well understood.

2. **Compliance with the Federal Land Policy and Management Act**

11-6 FLPMA requires the federal agency to "prevent unnecessary or undue degradation of federal lands and to protect the non-mineral resources of the federal lands". The magnitude of the impacts on water resources of this mine are such that the BLM is violating its mandate under FLPMA by permitting this mine as proposed.

The loss of water resources and the very great degradation of the water in the pit lake is neither necessary or required. By permitting this mine, over 450,000 acre feet of water will be created in the pit lake, which will be degraded, as discussed in the EIS. This large degradation of non-mineral resources is inconsistent with the BLM mandate for protection of those resources. Additionally, springs and seeps are likely to be lost and constitute an impact to agriculture and wildlife.

3. **Compliance with applicable state laws**

NAC 445.24352 requires that

"3. Bodies of water which are a result of mine pits penetrating the water table must not create an impoundment which

(a) has the potential to degrade the ground waters of the state; or
(b) has the potential to affect adversely the health of human, terrestrial or avian life.

11-7 As discussed below, the water quality in this pit will almost certainly adversely affect the health of terrestrial and avian life. The combination of arsenic and antimony in the pit lake are of sufficient magnitude that toxic responses are probable. Under any circumstances, however, this lake unambiguously has the "potential" to affect adversely the health of terrestrial and avian life.

11-8 Additionally, the regional groundwater gradients move water from the mined area towards the Humboldt River and tributaries, and movement of that water will ultimately move pit lake water into aquifers that have direct contact with the Humboldt River, and that supply drinking water. Thus, the potential clearly exists that groundwater contamination will occur and groundwater will be degraded. The burden of proof that it will not be degraded must be clearly placed on the mine proponents, but other than

Response to Letter 11

11-6 The State of Nevada has regulatory authority over the pit lake water quality and water rights within the state. As stated in 43 Code of Federal Regulations 3809.3-1, the BLM does not have the authority to preempt state laws and regulations relating to operations on federal lands under the mining laws. In addition, as indicated in the response to comment 2-14, the results of the pit water quality study and the ecological risk assessment indicated that significant impacts associated with the pit lake are not anticipated. Therefore, the BLM's actions in approving this project would not conflict with its mandate to "prevent unnecessary or undue degradation of Federal lands..."

The volume of the pit lake (as stated in the comment) is consistent with the Draft EIS. With respect to water quality degradation from the pit lake, the predicted concentrations in the pit lake were evaluated in the Draft EIS. Degradation was evaluated in terms of (1) exceedance of applicable water quality standards established for beneficial uses, and (2) potential risk to terrestrial, avian, and human life. In summary, the numerical flow modeling predicts that evaporation from the lake surface would keep the lake surface below the surrounding water table. Therefore, the pit lake is not predicted to discharge (or degrade) the ground water system. A pit lake risk assessment to evaluate potential risk to terrestrial wildlife, waterfowl, and humans was performed, and the results indicate that the pit lake should not pose a significant risk to terrestrial wildlife, waterfowl, or humans.

11-7 Please see the response to comment 2-14 regarding the monitoring of pit lake water quality, and see the response to comment 1-54 and Attachment C1 to Appendix C of the Final EIS for a more detailed explanation of the assumptions and processes used for both the screening-level and baseline risk assessments in determining that the future pit lake water quality would not adversely affect wildlife.

11-8 The potential for water from the pit lake to move outward into the ground water aquifer system is addressed in Section 3.2 of the Draft EIS under the heading "Pit Lake Development" for both the No Action and Proposed Action scenarios and is supported by Figures 3-28, 3-35, and 3-36. The summary provided in the Draft EIS is based on the results of numerical flow modeling performed by HCI and presented in HCI 1996a. In summary, the results of the flow modeling indicate that

Letter 11 Continued

11-8 assertions that it will not, we were unable to find any detailed treatment of this problem in the DEIS.

4. **Procedures for development of the response to public comments.**

We request a discussion and indication of the person/organizations which developed responses to the Sierra Club comments included herein. We ask that they be identified at least to the business/agency in which they are employed, and the location of that office. Who was the person/organization who developed the initial response, and what level of review did those responses receive. If the response is not from the BLM, we request information as to whether the respondent was retained/selected by the BLM, the EIS contractor or the mining proponent. Did the mining proponent have any part in selection of this review team.

We make this request because of substantiated concerns that the response to our comments may be developed by the contractor who also prepared a section of the EIS under direct authority of the mining proponent. For example, for the Round Mountain DEIS, the Sierra Club submitted extensive comments, many of which did not appear to receive serious consideration. We found out later that the response was written by the same contractor who conducted the study, and that response to the Sierra Club comments was essentially unchanged when presented in the FEIS. In this case, it is our understanding that the contractor was selected, hired, directed and paid by the mining proponent directly. Thus, rather than have a neutral regulatory scientist review the comments, they were reviewed by an agent for the mining proponent.

11-9

If the BLM allows the contractor for the mining proponent to review our comments, we ask that we similarly be allowed to review their input into the FEIS regarding the Sierra Club comments. This may seem a cumbersome process, but the BLM in Nevada at present gives the mining proponent far too much ability to shape the EIS and affect the ultimate conclusions. Rather than a "partnership", the BLM has given far too much discretion to the mining proponent to determine the outcome of the environmental impact analyses. Several geochemists are available who could provide comment on the validity of many of the assumptions used in the DEIS. . Dr. Jim Leike at Stanford University, Dr. Francois Morel at Princeton University or Dr. Lambis Papelis at the Desert Research Institute in Las Vegas are all internationally know scientists who are experts in the geochemistry of natural waters. Both Dr. Leckie and Dr. Morel were referenced in the PTI study on the predicted pit lake chemistry.

5. **Heap Leach and Tailings Closure**

11-10 The most significant problem which has become apparent in recent years regarding heap leach decommissioning is the potential for release of contaminants other than WAD cyanide. These include arsenic, selenium, fluoride, sulfate, mercury and other heavy metals. No discussion was made of any of these substances. Although cyanide can be

Response to Letter 11

as a result of evaporation from the lake surface, the elevation of the surface of the lake would be lower than the surrounding potentiometric surface of the regional aquifers. Consequently, the flow model indicates that there would be a permanent inward hydraulic gradient in all directions from the regional ground water aquifer toward the pit. A sensitivity analysis indicates that even if the evaporation rate were reduced from 42 inches per year to a very low 17 inches per year (which would raise the lake level), the pit lake would still have a continued inward gradient, and no outflow would occur.

11-9 The parties responsible for preparing responses to the comments in this letter are identified below. The individual most qualified to respond to each comment prepared the initial response. If the comment addressed a technical issue relative to a specific technical study (baseline data collection, computer model, etc.), the individual responsible for the study prepared the initial response because he/she is the most knowledgeable about the issue raised. The response was then critically and independently reviewed by the technical specialists on the BLM interdisciplinary team, including the BLM's in-house specialist and/or the BLM's EIS contractor. The BLM interdisciplinary team members revised the responses, as necessary. If the BLM interdisciplinary team members agreed with the initial response, no revisions were made.

BLM, Winnemucca District Office, Winnemucca, NV;
Lead Agency

Riverside Technology, inc. and subcontractors, Fort Collins, CO; Third Party EIS Contractor (for the BLM)
Subcontractors: ENSR, Fort Collins, CO
Shepherd Miller, Inc., Fort Collins, CO

Santa Fe Pacific Gold Corporation (SFPG), Golconda, NV

Hydrologic Consultants, Inc., Denver, CO; Ground Water Modeling (for SFPG)

PTI, Inc., Boulder, CO; Pit Water Quality Study (for SFPG)

Parametrix, Inc., Kirkland, WA; Ecological Risk Assessment (for SFPG)

Letter 11 Continued

oxidized efficiently, these other elements are not easily removed. Yet, they pose a substantial long-term risk because the heaps are a potential source of large tonnage of some of these contaminants. Because the heaps will be on public lands, the BLM will then potentially be responsible for long-term management of a contaminated site and the public will pay the bill.

11-10 The EIS should specify what concentrations of each of these contaminants will be allowed in drainage water from the heaps. It is insufficient to state that the state regulates these contaminants. The decision is a federal decision, and the BLM must take responsibility for ensuring that the closure of these operations does not pose a long-term risk. If those regulations are not yet in place, the BLM should take a conservative approach and use drinking water standards, or aquatic habitat standards for setting the water quality that will be required prior to closure. The DEIS does not meet the standards required in NEPA for a full discussion of the impacts unless a clear statement is presented on the concentration and total mass of various contaminants which will be permitted from the heaps. The Leach Pad discussion on page 2-44 is general, vague and insufficient, except for the pH and WAD cyanide discussion.

11-11 In the section on Cyanide Stabilization/Neutralization (p 2-44) a statement is made that the solution draining from the heaps will meet primary drinking water standards. Immediately after that paragraph, an additional paragraph notes that:

"If neutralization by rinsing does not achieve the required closure criteria, then SFPG would submit a proposal to the Nevada Division of Environmental Protection for an alternative heap leach pad closure method"

This statement is tantamount to admitting that closure will not meet the standards, and completely avoids the issue of explaining how they will remediate heap fluids. It also effectively removes the ability of the BLM to regulate contaminant discharge on public lands, except under very expensive and time-consuming federal laws. The time to discuss those alternatives is now. At least it is necessary for the BLM to get a commitment from the mining proponent that it will treat the discharge by some presently proven method. An example of a method which can work is reverse osmosis. This is expensive, but can get the job done. If this method (or a proven alternative) is included in the document, the public will have a much higher level of confidence that the mining company will not simply attempt to get a variance from the state. Major mines are now beginning closure in Nevada. When those companies are in closure, it is much more difficult to negotiate than during the permitting process. Simple removal of the paragraph cited above would also be sufficient. The BLM should simply require that the company comply with meeting primary (and probably secondary) standards. Sulfate and other common salts are a major issue in heap drainage and should be regulated. Would the BLM allow a different industry to dump thousands of tons of salts on public lands?

11-12 The DEIS indicates on page 2-44 and 2-45 that "detailed" permanent closure plans for heap leach facilities are on file with the Nevada DEP as part of the water pollution

Response to Letter 11

11-10 Decommissioning of heap leach facilities is regulated by the State of Nevada under Nevada Administrative Code 445A.430. The decommissioning methods summarized on pages 2-44 and 3-80 of the Draft EIS are in compliance with Nevada Administrative Code 445A.430. As stated on pages 2-44 and 3-80 of the Draft EIS, heap leach decommissioning would include circulating water through the heap leach pads until the solution meets primary drinking water standards. Nevada Administrative Code 445A.430 requires that effluent from the decommissioned heap leach pad does not degrade waters of the state.

11-11 Please see the response to comment 11-10.

11-12 As stated in the response to comment 11-10, the heap leach facility would be decommissioned in compliance with Nevada Administrative Code 445A. Nevada Administrative Code 445A requires that a closure

Letter 11 Continued

11-12 control permits. These plans were filed several years ago and do not cover many of the problems which have become concerns in the last 3-4 years. Thus, the assertion that they are complete is incorrect for purposes of NEPA, and they do not constitute and analysis of the impacts under NEPA.

11-13 Use of the Meteoric Water Mobility Procedure is mentioned throughout the document. The use of this method for assessing drainage water quality has never been established by any research and remains a poor test for assessing long term impacts on areas which will receive the discharge. We have made comments such as these previously. If the method is valid in a federal agency decision, that federal agency needs to show that this method indeed has utility and provide an indication that a federal regulatory agency has considered this method and accepted it for the purposes being used. Without that demonstration, reference to this method should be entirely removed.

6. **Reclamation**

11-14 Although goals are presented, we were unable to locate any firm discussion on revegetation levels that would be *required*. The Federal Land Policy and Management Act requires the agency to prevent "undue and unnecessary degradation" of the public land. Accepting anything less than 100 percent is unnecessary, since the 100 percent standard can be easily obtained. The company should be required to bring the land back to near that of the ecological potential.

11-15 No discussion is presented on the reclamation bond which would required and how the reclamation bond would be calculated. This lack of discussion is entirely unsatisfactory. Although the State of Nevada cannot require a bond for heap decommissioning, the BLM is required to bond for complete reclamation. There was no discussion on whether such a bond would be required and the DEIS does not provide any indication of what that bond covers or how it will be administered. How will the bond be held? Since the state does not bond for heap rinsing, the BLM needs to establish a separate bond, which should be a full bond for the costs and not allow for the "corporate guarantee" allowed by the state. The BLM should use standard federal methods for bonding. A clear and detailed discussion of how the bond will be developed, who will hold the bond and what are the release criteria must be provided. This is central to assessing impacts. Does the bond include rinsing of heaps?

7. **Water Quantity and Riparian Systems**

11-16 a. The map of perennial stream reaches in the study area, Figure 3-14A is incorrect. Other data presented contradict this map. For example, measurements presented in Table 3-3 show that Rabbit Creek at SW-9, 10 and 11 is perennial far below the mapped locations. Readings at SW-12 on Kelly Creek also suggest it flows most of the time. It is essential to realize that many of these observations were taken in 1994, an extremely dry year. The discussion states that presence of riparian vegetation is a factor in the decision of which reaches were perennial. In the overgrazed Great Basin, this is a

Response to Letter 11

plan for the heap leach facility be submitted to the state at least 2 years prior to planned closure. The Draft EIS states on page 2-45 that a detailed closure plan would be submitted to the Nevada Division of Environmental Protection 2 years before closure.

11-13 The Meteoric Water Mobility Procedure is required by the State of Nevada to evaluate the potential for dissolution and mobility of certain mine rock constituents exposed to meteoric water. The test consists of a single pass, 24-hour, column leach test designed to assess leachate that could be produced from the mine rock in the field. The BLM recognizes that the Meteoric Water Mobility Procedure test provides only an approximation of actual field conditions, and that no test exists to perfectly simulate solute concentrations that could be generated in water that runs off of or infiltrates into the mine rock piles. These test data are discussed in the EIS along with other geochemical test data, including static acid-base accounting and kinetic testing. The evaluation of potential impacts to water resources was based on consideration of the combined results of all of the geochemical tests (whole rock analyses, static acid-base accounting, kinetic testing, and Meteoric Water Mobility Procedure testing), along with the site-specific surface and subsurface conditions, including depth to ground water and soil attenuation capacities.

11-14 Comment noted. Please see the response to comment 1-45 and the clarification in Section 2.4.11.2 of the Final EIS regarding compliance with applicable requirements.

11-15 The reclamation bond is a surety instrument and is independent of the National Environmental Policy Act process. The reclamation plan is included in SFPG's Plan of Operations, which has been submitted to the State of Nevada. The reclamation plan includes a reclamation cost estimate, including costs to rinse the heap leach pads. The bond is held by the BLM in various financial forms that are acceptable to the State of Nevada. This information is in the public record. Also, please see the response to comment 1-45 and the added clarification in Section 2.4.11.2 of the Final EIS regarding reclamation.

11-16 With respect to the perennial reaches shown in Figure 3-14A of the Draft EIS, Rabbit Creek is not shown as a perennial reach since the creek naturally flows only in response to runoff events. As explained in Section 2.3.9 of the Draft EIS, SFPG discharges treated mine dewatering water (in accordance with its National Pollution Discharge Elimination System permit) into the lower reach of Rabbit Creek, located immediately above the Kelly Creek confluence. This mine discharge has sustained flows in lower Rabbit Creek and Kelly Creek

Letter 11 Continued

11-16 poor indicator on some streams, especially at the low elevations studied. We recommend the BLM redo Figure 3-14A and reassess the impacts on perennial streams discussed later in the DEIS.

11-17 b. On page 3-57, under the section Environmental Consequences, a fifth issue should be listed. That is: reductions in surface and ground water quantity for current users and water dependent resources from pit refill.

11-18 c. Also on page 3-57, in the list of impacts to water resources, an impact to surface water also occurs due to a measurable increase in the flow of streams or springs. This results from increased degradation and sediment movement.

11-19 d. This project will divert perennial and ephemeral stream channels. The Clean Water Act requires permits for fill in waters of the United States. At the very least, a Nationwide 26 permit is required for fill proposed in this DEIS. Quite possibly, due to the length of streams diverted, impacts will exceed minimal and a 404b permit will be required where alternatives must be considered and the least environmentally damaging possible alternative must be identified. Basically, the chemical, physical and biologic integrity of the waters of the United States must be retained. This DEIS fails to adequately address the requirements of the Clean Water Act.

11-20 e. The Rabbit Creek diversion, by decreasing gradient, will lead to a braided channel. Aggradation will occur because the channel will try to reach a gradient necessary for sediment transport. When a large flow occurs, the high stream power will cause a knickpoint to form which will migrate upstream causing an incised channel, destroying most of the riparian vegetation and causing localized groundwater level decreases. The DEIS does not address the impacts of this likely riparian and aquatic habitat loss.

11-21 However, the DEIS lacks adequate design drawings of the diversion. It is possible to hydrologically design a channel that will not degrade, and that does not need riprap. Please provide more detailed designs for the channel diversion.

11-22 f. The channel diversions are designed only for the 100-year storm. If we assume that the diversion fails when the 100-year flood is exceeded, there is a substantial chance that the stream will be diverted into the pit or near the mining operations at some point during operations or after the project is closed. The probability that a 100-year event will occur at least one time during the 12 year project life and during a 100 year closure life is calculated using the binomial distribution to determine the probability of no exceedances during the planning time frame:

$$Probability\ of\ exceedance = 1 - f_x(x;n,p) = 1 - \binom{n}{x} p^x q^{n-x}$$

Response to Letter 11

located downstream from the Rabbit Creek confluence. Figure 3-14A of the Draft EIS was intended to show only the approximate location and extent of natural perennial water sources in the hydrologic study area; stream reaches sustained by temporary mine discharge were excluded.

Regarding the location of the lower termination of the perennial reach of Kelly Creek as shown in Figure 3-14A of the Draft EIS, the flow data for surface water monitoring clearly show that this stream goes dry between SW-2 and SW-3. The flows recorded at station SW-12 are also located below and are sustained by the mine discharge. In addition, vegetation was just one of many factors considered in delineating perennial reaches. Other factors include measured flow data, fisheries studies, and infrared and color aerial photography.

11-17 The significance criteria for water resources presented in the Draft EIS state that if the Proposed Action or alternatives result in (1) a measurable reduction in flow of perennial streams or springs, or (2) a reduction in the quantity of ground water available for current or future uses, the impacts would be considered significant. The suggested addition, "*reduction in surface and ground water quantity for current users and water dependent resources from pit filling,*" is not necessary since this would already be covered by the two general criteria listed above.

11-18 It is assumed that the comment refers to measurable increases in degradation or sediment movement that could result from increased dewatering streamflows. Such considerations are incorporated into the second and third bulleted items in Section 3.2.2 of the Draft EIS. Potential impacts and mitigation associated with these concerns are addressed in Section 3.2.2.3 of the Draft EIS.

11-19 The project would not divert perennial stream reaches. Please see the response to comment 1-29 regarding SFPG's Section 404 Permit.

11-20 Channel rejuvenation and knickpoint migration require a drop in the base level (hydraulic control elevation) at some point in the channel. Given that the diversion would have a reduced sediment transport capacity and would result in aggradation (sediment accumulation), there is no potential for the base level to drop. Furthermore, significant aquatic habitat or riparian vegetation does not presently occur along the ephemeral Rabbit Creek channel reach to be affected, and would not establish to any great extent along the proposed diversion.

11-21 Please see the responses to comments 1-24 through 1-28 regarding the Rabbit Creek Diversion design.

Letter 11 Continued

11-22 where x is the number of exceedance in n years, p is the probability of the event in one year and q=1-p. When x is 0, the binomial equals 1 leading to:

$$1 - (0.99)^{12} = 1 - .8863 = 0.1137$$

$$1 - (0.99)^{100} = 0.6340$$

In other words, there is an 11 and 63 percent chance, that the diversion will fail during these two planning timeframes leading to major damage occurring on Rabbit Creek.

Additional comments focus on the groundwater monitoring and reporting of the results.

11-23 g. The DEIS provides very little information with which to evaluate the modeling results and hence the quality of the predictions. We recommend that figures showing the variability of hydraulic conductivity or transmissivity across the basin, initial heads, and boundary conditions including head and flux be provided. Also, the report should provide a figure showing a comparison of the calibrated steady state model results with measured water levels. Finally, a figure of the water level results after the transient verification compared to measured results should also be provided (this verification was discussed on page 3-60).

11-24 The DEIS implies the BLM expects the public to trust that the groundwater model produced by HCI is adequate. The document referenced for validating and calibrating the model is an unpublished HCI in-house document. Has the model been independently verified? Most models in use receive independent peer review that is published prior to general acceptance by the profession. The DEIS references two other mines which have used the MINEDW model (Gold Quarry and Lone Tree, page 3-58). Use of a model to make predictions does not validate the model. Only after the model has been verified by comparison of transient results of mining and pit refilling will the public have any confidence in the model results. Until this occurs, the BLM is relying on unproven models, assumptions and computer code.

11-25 h. Pit dewatering and excavation will result in a massive groundwater deficit in the local basin and add to the overall deficit in the Humboldt River basin. The No-Action alternative, which is continued mining for four years, calls for the dewatering of about 40,000 acre-feet of water over the next four years. This is about the volume of the drawdown cone around the mine based on figures in the DEIS. While reference is made to reinfiltration, most of the dewatering is consumptively used for mining and milling. There is also a minimum amount discharged to Rabbit Creek, but we presume much of it infiltrates. Because it represents wetting of previously dry soil, it does not recharge the groundwater, but is essentially bound in the unsaturated zone or evapotranspired. The open pit will have about 130,000 acre-feet, which is also a deficit to the basin. The

Response to Letter 11

11-22 The calculations presented in this comment for the probability of occurrence are correct; however, the 100-year, 24-hour design storm is a commonly accepted design criterion for such diversion structures. The proposed diversion also incorporates a 2-foot freeboard above the calculated water surface for the peak flow from such a storm. It should be noted that the duration of the peak flow rate would be short, and that over the duration of runoff from the design storm, flow rates would be significantly lower. It should also be noted that proposed process components, such as heap leach pads, mill facilities, and tailings impoundments, have runoff controls that are adequate to accommodate the 100-year, 24-hour storm independently of the proposed Rabbit Creek Diversion. Monitoring and mitigation measures in Section 3.2.4 of the Final EIS have been developed to further address such concerns.

11-23 A summary of the hydrologic framework, conceptual model, model domain and mesh, and calibration of the model are presented in the Draft EIS. Details describing the numerical model, parameter assignment, and calibration results are presented in HCI's technical report (1996a) incorporated by reference into the Draft EIS. As stated in Section 3.0 of the Draft EIS, copies of primary technical reports, including the HCI 1996a report, are available for review at the BLM State Office in Reno and the BLM Winnemucca District Office.

11-24 The "proprietary" numerical code *MINEDW* has been subject to considerable review. The main portion of this code originated from *FLOW3D,* which was developed by Timothy J. Durbin while employed with the U.S. Geological Survey. A description of *FLOW3D* is given in three U.S. Geological Survey reports: Durbin and Berenbrock 1985, Durbin and O'Brien 1987, and Mitten et al. 1988. Supporting documentation for MINEDW (mathematical basis, model structure, model validation, and comparison of MINEDW results with the results from a MODFLOW sample problem described in the MODFLOW documentation (McDonald and Harbaugh 1988) are provided in HCI 1993.

As part of the data adequacy review process, HCI's numerical flow model for the project was critically reviewed by Dr. Tom Olson, BLM hydrogeologist, and the third-party EIS contractor, Riverside Technology, inc. Riverside Technology, inc. was assisted by Dr. Paul Witherspoon, a world-renowned expert in the analysis of ground water flow in complex hydrogeologic settings. On other EIS projects in Nevada, HCI's MINEDW model has been critically reviewed by Dr.

Response to Letter 11

Mary Anderson and Dr. William Woessner, two renowned modeling experts.

A comparison of transient measured and model-generated water levels for 30 monitoring wells in and around the vicinity of the mine was presented in the documentation of ground water flow modeling results on file at the BLM Winnemucca District Office, as well as the BLM State Office in Reno (HCI 1996a).

MINEDW also has been used to analyze the McCoy/Cove Mine. The results of this analysis have been published and presented by Hanna and Streiff (1994). In addition, 4 years of post-EIS modeling at Gold Quarry (HCI 1996b) have demonstrated the following:

- The predictive capability of the Gold Quarry ground water model
- The ability of *MINEDW* to accurately solve a system of mathematical equations describing the flow of ground water
- The usefulness of such a modeling tool to update and improve the understanding of the hydrogeology of a given system

11-25 As stated in Section 3.17.2 of the Final EIS, pumped ground water consumed in the mining and milling operation or loss through evaporation would remove approximately 41,500 acre-feet for the No Action alternative and 126,000 acre-feet for the Proposed Action. To address the question of ground water deficits, a discussion of the change in the annual ground water budget at different times has been added to Section 3.4.4 of the Final EIS. The simulated annual ground water budgets for the end of mining and in the postclosure period shown in Table 3-20 of the Final EIS provide an estimate of the cumulative changes to the annual ground water budget resulting from the combined effects of mine dewatering, pit lake evaporation, and pumping for agricultural and other mines. As shown in Table 3-20, a substantial amount of the ground water removed by the dewatering system is returned back to the ground water system in the mine's reinfiltration basins.

The comment that the water discharged *"does not recharge the groundwater, but is essentially bound in the unsaturated zone or evapotranspired,"* is incorrect. Only a very small percentage of the total water infiltrated would be retained after gravity drainage of the alluvium. After initial saturation, the alluvium would not retain any additional water, and all remaining water infiltrated would essentially move through the alluvium and recharge the ground water aquifer

Response to Letter 11

system. For example, the total required basin area is approximately 190 acres, and the average depth to water is 125 feet results in a total unsaturated volume beneath the basins of approximately 23,750 acre-feet. The specific retention within the alluvium is estimated to be on the order of 15 percent (assuming an average porosity of 35 percent and an average specific yield of 20 percent). Using these values, the maximum volume of water that could be retained within the unsaturated zone would be approximately 3,562 acre feet (23,750 acre-feet x 0.15 percent) This volume represents approximately 3 percent of the total volume of water to be discharged under the Proposed Action. The actual volume retained within the unsaturated zone would be less than 3 percent, however, since the alluvium contains some existing moisture content prior to infiltration. As stated in Section 2.3.10 of the Final EIS, SFPG has committed to physically controlling the establishment of vegetation within or along the margins of the reinfiltration basins. In addition, under the current stipulations imposed by the State Engineer, the evaporative loss from the reinfiltration ponds cannot exceed 7 percent of the water discharged to the basins. Therefore, water loss through evapotranspiration processes should be minimal.

Letter 11 Continued

11-25 existing project, corresponding to the No Action alternative, represents a deficit of near 170,000 acre-feet.

11-26 Pumping in the Proposed Action consists of an additional 200,000 acre-feet of dewatering which appears to be near the volume of the drawdown cone. The pit will have a volume of 460,000 acre-feet. Therefore the total deficit due to this mine is about 660,000 acre-feet, or an additional 470,000 acre-feet over the current mine. We would add that predictions of pumping rates as this project excavates deeper become dubious because the pit intersects more bedrock; water developed within due to fractures and the like is more difficult to predict. Predictions of dewatering rates have been quite wrong in the past at other mines and become much more uncertain at deep drawdowns such as this mine. Also, the use of a groundwater model of dubious reliability (see above) increases the doubt one should have about the predictions. Certainly, this project leads to groundwater mining which is in opposition to Nevada State water policy.

11-27 Eakin and Lamke[1] found that 6000 acre-feet/year flows from the Little Humboldt River in both groundwater and surface water to the Humboldt River. They did not address Evans Creek directly. The DEIS predicts that baseflow in the Little Humboldt River will decrease by up to 20 % or 0.49 cfs (355 acre-feet/year). Other predicted decreases are much less. Yet, Figure 3-28 implies that the lake will be at least 90% full within 75 years. Assuming the drawdown cone is also refilled, about 90% of 660,000 acre-feet will be made up within 75 years. Realizing that the rate of refill is faster in early years[2], approximately 7920 acre-feet/year is needed to fill the lake and drawdown cone by 90% within 75 years. If the water does not come from the Little Humboldt or Evans Creek, what is the source of refill? The alluvium thickness varies from 600 feet to over 1200 feet. It is reasonable to assume that much of the flow must come from surface, alluvial aquifers. Drawdown cones south from the pit suggest that most subsurface flow along Evans Creek will be intercepted. The DEIS must address the source of water, alluvial or deeper aquifers, to pit refilling.

11-28 The DEIS does not address impact on the Humboldt River itself. Our basic contention is that flow necessary to refill the pit and drawdown cone will change flow gradients and divert water from the Humboldt River[3]. At least, most of the subsurface flow from the basin will be intercepted. This will result in a long-term loss to the Humboldt River. Also, even assuming that boundary condition problems previously alluded to are not a problem, water will be drawn from the Humboldt to replace water

[1] - Eakin, T.E. and R.D. Lamke, 1966. Hydrologic reconnaissance of the Humboldt River Basin, Nevada, Water Resources Bulletin No. 32. State of Nevada, Dept. Of Conservation and Natural Resources.

[2] - In other words, accepting that our approximation understates the early impacts.

[3] - Inaccuracies in predictions could result from inappropriate boundary conditions on the model. For example, a constant head boundary does not limit the flow into the region being studied. This could result in a implicit assumption of improper recharge somewhere out of the basin. But, I have not yet seen the detailed model. The numbers in the DEIS just do not compute.

Response to Letter 11

11-26 The model calibration results indicate the model is reasonably representing the system, particularly in its ability to match trends in head change in the pit area and at locations several miles away in Kelly Creek basin. The fact that bedrock is fractured has no bearing on the model's ability to make reasonable predictions because the bedrock in this case, and in most other cases involving models of similar areal extent, is modeled as an equivalent porous media. Representing the fractured bedrock as an equivalent porous media is a volumetric averaging of the hydraulic properties of the rock mass and the fractures. This is the standard approach used to numerically model ground water flow systems at this scale. The numerical model used for modeling ground water flow in the hydrologic study area has been critically reviewed during the EIS process and has been found to provide a reasonable estimate of the potential hydrologic effects resulting from dewatering, pit lake development, and infiltration.

11-27 The assumption that the cone of depression completely refills with water is without basis. As illustrated in Figure 3-32A of the Draft EIS, because of the passive inflow of ground water to the pit lake to replace water loss through evaporation, a residual cone of drawdown is predicted to exist for the foreseeable future. The source of the water extracted for mine dewatering, agricultural pumping, or for pit inflow is summarized in the simulated annual ground water balances provided in Table 3-20 of the Final EIS. The pit lake is only one of many mechanisms that would remove ground water from the hydrologic study area. The sources of inflow into the ground water system include recharge from precipitation, and water that infiltrates from crop irrigation and the Twin Creeks reinfiltration basins. When the outflow is greater than the inflow, the balance is made up in part by a reduction of the ground water in storage in the basin and in part by (1) reductions in evapotranspiration and (2) a net reduction in ground water discharged as underflow and surface discharge. At the later stages of pit infilling (100 years postmining), the water budget is nearly in balance. The modeling and simulated annual water balance assumes that all of the currently held water rights for agricultural pumping continue at full capacity for the indefinite future. The BLM understands that SFPG has recently acquired additional water rights (through a property purchase) in the Kelly Creek basin. If the amount of agricultural pumping is reduced in the future, then the long-term reduction in water in storage in the basin or the reduction in evapotranspiration and ground water discharge to the surface would be reduced or eliminated.

11-28 The flow modeling indicates there would be no significant direct or indirect impacts to the Humboldt River. The potential effects to surface water resources are presented in HCI 1996a. Indirect effects to the

Letter 11 Continued

11-28 from the lower basin. This will impact the Humboldt River. The lack of consideration of this impact is a major defect of the DEIS.

11-29 Based on the continued growth of the drawdown cone while the pit lake fills, it is likely that most flow in the several streams draining south from the Osgood and Snowstorm mountains will go to fill the deficit. We refer to Evans, Rabbit and Kelly Creek. Chimney Creek, draining north, will also likely go dry. Approval of this project basically assures that most surface water sources and riparian areas within the local basin will dry in the long run to the detriment of wildlife and livestock alike.

11-30 i. We also note that discussion of reinfiltration in the proposed action is very nebulous. We are uncertain whether the same plan as for the No Action alternative will be used, additional basins will be constructed, or, as is implied at certain points, no reinfiltration will be used. In any case, very little of the actual dewatering pumpage will be recharged which leads to additional groundwater mining from this basin.

11-31 Estimated recharge is 22,000 acre-feet/year (Table 3-6) while the loss to evapotranspiration is 11,200 acre-feet/year (page 3-49) and current appropriations are 16,620 acre-feet/year, therefore the basin is currently being mined of groundwater. Additional pumpage predictions for the Proposed Action is an increase from 5000 gpm to 12,300 gpm, or an additional 11,800 acre-feet/year will be pumped. The total pumpage of 28,420 acre-feet/year exceeds recharge-ET by more than 18,000 acre-feet/year and represents a very substantial mining of the groundwater which is both contrary to Nevada State Water Policy, and not protective of non-mineral resources on the public lands as required by BLM regulations.

11-32 j. The overall Humboldt River basin deficit after mining ceases, based on currently operating and proposed mines, now probably exceeds 4,000,000 acre-feet, of which 660,000 acre-feet is due to this proposal. This is about a 75% increase since our original survey of the issue two years ago[4]. It includes both the volumes in drawdown cones and the pits. It represents about 40 percent of the overall water quantity stored in the Humboldt River basin upstream from Winnemucca. Because it is currently unknown how the recharge of this volume will affect flows in the Humboldt River, the impacts of the reductions of flow on downstream surface water rights in Lovelock or the wells providing municipal water for Winnemucca is unknown. But, to put it in perspective, the annual flow past the city of Winnemucca in both surface and groundwater is about 160,000 acre-feet per year. If all of the flow in the river, surface and ground water, went to make up the deficits created upstream from the city, it would take 25 years.

This project represents more than 15% of the deficit in the Humboldt River and is, therefore, a major contributor to the cumulative impacts on the Humboldt River. A proper assessment of these effects should be included in the DEIS.

[4] - Myers., 1994. Cumulative hydrologic effects of open pit gold mining in the Humboldt River drainage, A report to the Sierra Club, March 10, 1994, Reno, T, NV.

Response to Letter 11

Humboldt River via the Little Humboldt River would be nominal since surface water from the Little Humboldt River rarely reaches the Humboldt River because of agricultural diversions and infiltration in Paradise Valley (see page 3-31 of the Draft EIS). With respect to infiltration, please see the response to comment 11-25.

11-29 The statement that *"...Evans, Rabbit and Kelly Creek, Chimney Creek, draining north, will likely go dry,"* and that *"Approval of this project basically assures that most surface water sources and riparian areas within the local basin will dry in the long run..."* is without scientific basis and is contrary to the BLM's understanding of the ground water flow system and to the numerical modeling designed to simulate the potential hydrologic effects from pit dewatering and postmining pit lake development. The baseline hydrologic data, conceptual model, and numerical flow model (including the model set-up, assumptions, input parameters, static and transient calibration, and sensitivity analyses) were critically reviewed for adequacy by both the BLM (Dr. Tom Olsen) and the third-party EIS contractor (Riverside Technology, inc.) and its consultant (Dr. Paul Witherspoon).

Rabbit and Chimney creeks are ephemeral streams that flow only during spring runoff and are not connected to the regional ground water system. Field data indicate that Evans Creek combines with the Hot Springs and normally infiltrates just west of the spring, long before reaching the Humboldt River. Impacts to Evans Creek are included in the hydrologic effects on the Hot Springs, which were addressed in the Draft EIS.

The field data from Kelly Creek indicated that there is a disconnection between Kelly Creek and the regional water table west of the North Nevada Rift near Kelly Creek Ranch. Therefore, the portion of Kelly Creek that may be affected by drawdown from the pit is a losing reach and would not be impacted.

11-30 As discussed in Section 2.3.9 of the Draft EIS, all water above the 4,300-gallon-per-minute consumptive rate would be reinfiltrated into reinfiltration basins and the bed of Kelly Creek. This consumptive rate applies to both the No Action alternative and the Proposed Action. Please also see the response to comment 11-25.

11-31 A discussion of potential changes to the annual water balance at various points in time has been added to Section 3.2.3 of the Final EIS. The annual water balance for the hydrologic study area is more complex than represented in the reviewer's comment. For example, a

portion of the water extracted from the study area as a result of mining and agricultural activities is balanced by a reduction in ground water outflow from evapotranspiration and predevelopment ground water surface and subsurface discharge. The total deficit volume presented by the commentor is also incorrect since this volume has not been adjusted to account for the fact that a substantial amount of the water extracted for mining is actually recharged back to the ground water system via the reinfiltration systems (please see the response to comment 11-25 regarding reinfiltration). Because of these omissions, the annual change in storage (outflow minus inflow) resulting from the project as estimated by the commentor is exaggerated. In truth, as presented in Table 3-20 in the Final EIS, even considering a year when the maximum ground water withdrawal at the mine would occur (the final year of mining under the No Action alternative), the annual change in storage in the basin is not estimated to increase over existing conditions. Storage would not change due to recharge through infiltration at the mine and other adjustments in the basin balance, as mentioned above. Please also see the response to comment 11-27 and the discussion of the water balance in Section 3.2.3 of the Final EIS.

11-32 The study area for cumulative impacts to water resources consists of the hydrologic study area defined in Section 3.2.1.1 of the Draft EIS. The hydrologic study area covers approximately 645 square miles and includes the Kelly Creek basin and portions of the Clovers and Little Humboldt basins, as illustrated in Figure 3-11 of the Draft EIS. The predicted area of drawdown does not extend outside of the study area, and no reductions in baseflow are predicted to occur to the Humboldt River (see the response to comment 11-28). Because of these results, the BLM does not feel it is necessary to expand the cumulative impact area for water resources to include the entire Humboldt River basin.

Letter 11 Continued

11-33 This document acknowledges major impacts on water quantity and quality for at least 100 years. The BLM should require a require the mining company to mitigate the consequences of these impacts. It should be sufficient to clean up groundwater contamination and reimburse water rights holders whose rights are impacted beyond that predicted. The mitigation should also move the diverted streams around the pit. The risk of a 100-year flood in the next 100 years is sufficient to assume that one or more streams will be diverted into the pit.

8. **Water Quality**

11-34 We reviewed the background PTI document on the predicted pit lake water quality of the Twin Creeks mine. This model has been used at several previous mines, and although it was innovative four years ago for Gold Quarry, it has yet to be tested on any actual pit lake. Although we recognize the amount of expense and effort that went into this document, it remains only a very rough estimate for a pit lake water quality. Many of the assumptions used in the model, particularly the mass of contaminant contributions from reactive rock, are untested and of sufficient uncertainty that the results of the geochemical calculations are unreliable. The so-called Monte Carlo analysis of uncertainty in the predicted water quality is valid only if the model assumptions are valid, which we believe are probably incorrect. As presented, the predicted water quality assessment, while interesting, has very little merit for predicting water quality for regulatory purposes, and is certainly insufficient for any wildlife risk assessment. We find it highly disturbing that this model continues to be used for major mining decisions by the BLM over a period of four years without requiring that it be tested. Real data would go a long way towards reassuring the public that these lakes will not be long term public costs.

11-35 However, for the Twin Creeks case, real data are available, from the Getchell pit lakes which were created in the late 1960's. We were surprised that these data were not utilized for discussions on the pit lake at Twin Creeks. The Twin Creeks mine and the Getchell mine lie within close proximity of each other (4 miles); both are within the northeast trending mineralized zone known as the Getchell Trend or Potosi (Getchell) Mining District ; both have mineral deposits associated with sulfides which are primarily hosted in the Paleozoic sedimentary rocks (DEIS page 3-9 and 3-10). Thus, one would expect that, at a minimum, the DEIS would use the data from these pit lakes (which have been dewatered and are now being remined) as a gross check on the reliability of the models used for predicting the pit lake chemistry of the Twin Creeks.

We have included some of the information we have on the Getchell Mine pit lakes. Three lakes were formed, and several sets of data were obtained on these lakes between 1968 and 1983. The water quality in these pits varies, but water quality in the each of the pit lakes is poor, with sulfate concentrations of 1380 mg/L to 1610 mg/L. TDS varies from 2110-2420 mg/L. The pH of the separate lakes is particularly variable and ranges from 5.0 to 7.7, and is a probable reason why the arsenic concentrations vary from 0.009

Response to Letter 11

11-33 Comment noted. Monitoring and mitigation measures for stormwater control provided in Section 3.2.4 have been revised in the Final EIS in response to this comment. Proposed stream channel and stormwater diversions would route surface flows around the pit. Mitigation measures WR-8 and WR-9 have been amended in the Final EIS to address these concerns and minimize surface water contributions to the pit.

11-34 The conceptual model of water quality in the Twin Creeks pit lake includes the principal components described in peer-reviewed literature on mine pit lake geochemistry (e.g., Morin 1990; Ross 1992; Miller et al. 1996). The specific techniques used to make quantitative predictions of Twin Creeks pit water quality follow the recent approaches used at other mines (e.g., Gold Quarry [PTI 1992], Lone Tree [PTI 1994], Mule Canyon [SMI 1995], and Crown Jewel [Schafer and Associates 1995]).

The quantitative model used to predict water quality in the Twin Creeks pit lake is substantially improved over the model used for the Gold Quarry mine in 1992. The model reflects improvements and refinements made during pit lake studies subsequent to Gold Quarry, including Magma's Robinson Project, SFPG's Lone Tree Mine, the Round Mountain Mine, and Newmont's Bootstrap/Capstone and Batu Hijau (Indonesia) projects. For example, the limnologic modeling component has been improved, additional chemical constituents have been included, and a detailed assessment of uncertainty has been added.

The predictive modeling of water quality in the Twin Creeks pit lake followed accepted guidelines for research used to support policy decisions. These guidelines include providing adequate documentation to allow independent reproduction of results; explicitly reporting uncertainty, including peer review of methods; allowing open debate about alternative models; and empirically testing predictions (Henrion 1984). The paragraphs below describe how each of these topics was handled in the Twin Creeks pit lake study.

Response to Letter 11

Provide sufficient information on data and assumptions to allow an independent reviewer to reproduce the results.

The pit lake report (PTI 1996) includes a description of the conceptual model (Section 1.2), a list of assumptions (Section 7.1.2), and references for all computational models used in the calculations. All site-specific model data are presented either in tables or figures.

Explicitly report uncertainty.

Uncertainty was estimated for each key model parameter and was propagated through the model calculations to obtain estimates of uncertainty for each corresponding water quality parameter. These quantitative estimates of uncertainty were reported for all predicted values.

Conduct a peer review.

The Twin Creeks pit lake model follows generally accepted procedures that have been used to make similar forecasts at other mines (see references above). As with all technical EIS documents, the pit lake report underwent review by the BLM and its technical subcontractors.

Encourage an open debate and consideration of alternative models.

The public comments and technical reviews required by the EIS process satisfy the debate requirement and allow the introduction of alternative models. The requirement for responding to comments ensures that these alternatives are considered. Specific comments on previous pit lake reports stimulated development of additional components for the Twin Creeks model. Specifically, a detailed limnological modeling component was added (CE-QUAL-W2) (Cole and Buchak, 1995), and antimony was incorporated into the model in response to comments from ecological risk assessment reviewers. The number of samples was increased, and the results were reported within a probabilistic framework in response to requests for more detailed assessments of uncertainty. Requests for additional empirical validation of model predictions prompted an extensive, year-long study of metal cycling and limnology in three existing mine pit lakes.

Conduct empirical testing.

There are no mine pit lakes with which PTI's water quality predictions can be compared directly to measured conditions in the lake. The field

Response to Letter 11

of detailed predictive modeling of pit lake water quality is less than 10 years old, and none of the lakes modeled by PTI has yet filled with water. This absence of an empirical comparison for model predictions is a valid concern, and predictive modeling of pit lake water quality will benefit greatly when such a comparison can be made. This unavoidable situation is a component of most policy-focused analyses; decisions must be made regarding conditions that will exist in the future, but data sets are limited and fully tested models are often not available.

An effort was made to compensate for the absence of a comprehensive validation of the predictive model. Careful attention was paid to the first three components of policy-focused research. Empirical comparisons of individual model components to measured, site-specific values were provided, where possible. Verification of model components using empirical testing included the following:

- A laboratory procedure was designed to measure chemical reactions in evaporatively concentrated ground water to simulate future conditions in the terminal pit lake. Reactions observed in the laboratory were consistent with predictions made by the equilibrium chemical model.

- Acidic wall rock leachate was mixed with Twin Creeks lake water, and the observed metals adsorption was within the range of uncertainty predicted by chemical modeling.

- Oxidation rates were measured in Twin Creeks sulfide rock using a soil vapor probe and oxygen monitor. The measured rates of oxidation matched those predicted by chemical modeling.

- The model incorporated wall rock leachate and ground water compositions that were determined by analyzing samples from the Twin Creeks Mine.

The pit lake water quality modeling incorporated important aspects of previous pit lake studies. The modeling is well documented and reproducible and considers uncertainty in input and output parameters. The model underwent peer review, and alternative methods were considered where appropriate. The model is further strengthened by the incorporation of extensive site-specific ground water and rock chemistry data and the field verification of individual model components. In addition, a study of analogous lakes to further test and validate the modeling approach is underway. Therefore, the pit lake modeling performed for the Twin Creeks Mine is adequate for characterizing the water quality the pit lake.

Response to Letter 11

11-35 The geochemical evolution of each pit lake is dependent on the site-specific geologic and hydrogeologic conditions at the mine, such as (1) the types of rocks and minerals exposed in the final pit walls and their potential for acid generation and metals mobilization, (2) the quality of the ground water flowing into the mine upon cessation of dewatering, and (3) the pit configuration and resultant pit water balance (e.g., evaporative loss, rate of ground water inflow and outflow, and surface runoff). Although the BLM has not reviewed any published data regarding wall rock geochemistry or pit hydrology (this information is apparently not available) for the Getchell pit lakes, it appears that the geologic and hydrologic conditions for the Getchell pits and the Twin Creeks South Pit are different. For example, the Getchell pits are located along the flank of the Osgood Mountains, and the pit walls are presumably composed of bedrock. In contrast, the Twin Creeks South Pit is situated on the floor of the Kelly Creek basin, and a large percentage of the material exposed in the Proposed Action pit would consist of alluvium. Geochemical test data for the Twin Creeks South Pit indicate that, due to the calcareous nature of the alluvium and some bedrock units, approximately 91 percent of the rocks exposed in the final surface would have a positive net neutralization potential. As a result, this material would tend to buffer acid produced through the oxidation of sulfides (PTI 1996). Because of the different geologic settings, the geochemical characteristics of the material exposed in the Getchell pits may be quite different from those exposed in the Twin Creeks South Pit.

The pit lake configuration (size, lake surface area, volume, depth, area of exposed rock) is also different between the relatively small Getchell pit lakes and the much larger and deeper future Twin Creeks pit lake. Therefore, the water balance could be substantially different between the Getchell pit lakes and the Twin Creek South Pit. All of these factors would contribute to the water quality in the lake. Furthermore, the composition of the ground water within the bedrock in this area is known to be highly variable over short distances. This is demonstrated by the great variability in the concentration of arsenic and other constituents in the South, Central, and North pit lakes at the Getchell Mine reported in 1987 (BLM 1987b) and in the variability of ground water quality from monitoring wells located near the Twin Creeks South Pit (Table A-2, Appendix A of the FEIS). In addition, a major ground water component for the Twin Creeks pit lake is the alluvial aquifer that daylights in the pit. Again, this alluvial aquifer is not present in the Getchell pits. For these reasons, it is probable that the bulk composition of the ground water flowing into the Getchell pit lakes differs from the predicted composition of the ground water that would discharge to the Twin Creeks pit. In summary, considering the

Letter 11 Continued

mg/L to 0.38 mg/L. The high sulfate concentrations found in each of these lakes is a good indicator of sulfide oxidation processes. Antimony was found only sporadically, and only at 0.2 mg/L when detected and reported by Conoco. Of particular interest is the depth profiling in the South pit. This pit lake showed substantial stratification between the 5 ft sample depth, compared to the 70 ft sampling depth; the respective sulfate concentrations were 858 mg/L and 1350 mg/L. TDS, pH and arsenic concentrations varied dramatically also. Only in the North pit did the water not appear to be stratified; pH, TDS, sulfate and arsenic did not vary substantially over an 80-ft sampling depth. Appreciable dissolved iron concentrations were reported for each pit lake(0.16-2.0 mg/L). Elevated concentrations of cadmium, nickel, and lead were also observed in these pit lakes. Uranium was also observed, and in one sample of the overflow from the South Pit (road) it was observed at 1.881 mg/L.

11-35

We mention the above data simply to show the substantial differences between what was found in the Getchell Pit lakes and what is predicted in the Twin Creeks pit lake. The predicted TDS at 5 years is 270-390 mg/L and sulfate 85-190 mg/L for the two pit separate lakes at Twin Creeks which will eventually be one pit lake. Both concentrations are 7-10 times lower than found in the Getchell lakes. The pH is lower by over two pH units in the south and center pit lakes than predicted in the Twin Creeks mine. Antimony concentrations in the Getchell lakes are substantially lower than in Twin Creeks. The reported dissolved iron concentrations are 3-5 orders of magnitude higher in the Getchell lakes than predicted in the Twin Creeks mine. The model predicts that Twin Creeks will be well mixed; this was not observed in at least one of the Getchell lakes. The point we wish to make is that no geochemical model at present can predict a pit lake water quality, except in situations where the rock is completely unreactive. This is obviously not the case for the Twin Creeks mine.

11-36

Perhaps the variable with the greatest uncertainty is amount of sulfide oxidation that occurs when water is removed from the cone of depression created by pumping. When water is removed, air penetrates surfaces surrounding the mine which were largely reduced systems (as is indicated in the DEIS for Twin Creeks). It is insufficient to examine only the ultimate pit surface to estimate the amount of oxidation which will occur. Additional oxidation is almost certain to occur in those places that were exposed to oxygen in the cone of depression. This can extend kilometer distances from the pit. As the water table recovers, water flowing into the pit will carry those contaminants which have been released by oxidation. We do not know how to estimate that amount of oxidation, but the differences in sulfate levels from the Getchell mine lakes to the predicted Twin Creeks pit lake suggests that the model is substantially underestimating the degree of oxidation which is likely to occur.

11-37

We argue that the model results are presented without the appropriate qualifiers. We made the same arguments in a previous set of comments suggesting that the model results were different than other pit lakes. The response was made that each lake is different and not comparable. However, in this case our argument is stronger, since data from a nearby series of pit lakes suggest that the geochemistry is likely to be substantially

Response to Letter 11

different geologic and hydrologic settings, pit wall materials, pit lake configuration and water balance, and variable ground water compositions, it would not be appropriate to use the Getchell pit lake water quality data to draw conclusions about water quality in the Twin Creeks Proposed Action pit lake.

11-36 Calculations were performed to estimate the potential effect of sulfide bedrock oxidation on the pit lake water quality associated with drawdown and partial recovery of the water table. A detailed description of these calculations is provided in Attachment F1. In summary, the estimate considered (1) the mass of oxygen introduced to sulfide bedrock due to advection, and (2) the mass of oxygen introduced to sulfide bedrock from diffusion over the exposure time to estimate the total mass of oxidation products (acid and sulfate) that could potentially be produced from the exposure of sulfide minerals as the water table is lowered. The estimate also considers that the oxidation products would be released by flushing as the water table rebounds and as water infiltrates through the unsaturated zone. In addition, the acidity produced was compared with the available neutralization capacity of the bedrock material to evaluate the net acid release.

The results of these calculations are described in Attachment F1 and demonstrate that:

- The total amount of sulfate in the pit lake is predicted to increase by as much as 12 percent at 230 years after mining; this predicted maximum 12 percent increase is within the error for the concentrations estimated by the pit lake model.
- The rock contains enough buffering capacity to neutralize the acidity that could be produced by these two mechanisms and, consequently, most of the metals associated with this acid release would be attenuated (as demonstrated by the humidity cell test results).

11-37 Regarding the comment that the results of the pit lake study were presented "without appropriate qualifiers," uncertainties associated with predictions of future water quality were clearly disclosed in the Draft EIS. For example, on page 3-75, the Draft EIS states, "It is important to note that because of uncertainties of future climatic

Letter 11 Continued

11-37 different than predicted by the models. The BLM should ask the question of which source of information is most reliable; real data from a nearby set of lakes, or model results which use assumptions which have never been tested, much less verified.

11-38 Much of the above discussion is simple academic arguing over model verification and understanding the system. The model results may be correct, or we may be correct in that the water quality is likely to be very poor, based on data from nearby pit lakes. What is ultimately at stake in this case, however, is the regulatory decision that the BLM must make. Since the BLM has no quantitative standards for pit lake water quality on public land, we are very concerned that the agency appears to have defaulted to the only regulation which exists to prevent toxic lakes from being formed. This is the Nevada state regulation indicated above which prohibits allowing a lake to form which has the *potential* to adversely affect the health of avian or terrestrial wildlife. The term "potential" is clearly difficult to interpret, but a reasonable person can ask themselves a simple question whether it is reasonable to suggest that this pit lake water is of sufficiently poor quality that it may adversely affect the health of wildlife. Even in the better quality model water, and certainly in the pit lake water of the Getchell mine, the potential clearly exists that the combination of sulfate, arsenic, antimony and other heavy metals may be problematic for the health of wildlife.

11-39 It is also likely that this pit lake will contaminate surrounding groundwater. Although the cone of depression created by evaporation from the pit lake surface will certainly reduce the amount of water flowing from the pit, we are unaware of any data which shows that a pit lake water will not migrate with the regional groundwater. It is very likely that drinking water standards for sulfate, antimony, arsenic, and TDS will be violated. Thus, creation of this pit lake should not be allowed under Nevada regulations which prohibit forming a lake by mining which has the potential to degrade groundwater quality.

11-40 The discussion of open pit reclamation on page 2-47 uses a common rationale for not backfilling by suggesting that removal of backfilled material will preclude recovery of mineral reserves if new metallurgical processes or increased gold prices allow mining of ore which is presently subeconomic. This statement is true only if those costs compare to the costs of pumping, treatment and discharge of 450,000 acre-feet of water from the pit lake. Unless a valid comparison is made of relative costs, this paragraph should be removed. The "evidence of mineralization" argument is also invalid, since it is unlikely that mineralization will be any easier to determine under 650 feet of water than it would be by drilling the same depth. Finally, the cost of backfilling should be compared to the cost of treating the pit lake in perpetuity. As presently proposed, the pit lake will almost certainly offer the potential to adversely affect terrestrial and avian life, and is therefore is inconsistent with Nevada law and one very real option is to plan the mining operation for eventual backfill.

Response to Letter 11

conditions, ground water flow rates, and ground water chemistry, the confidence in the predictions of pit lake water quality decreases with increasing time after the end of mining. Therefore, predictions made for several decades into the future should be viewed as indicators of relative trends in concentration rather than absolute values." For consistency, the statement has been added to the Summary in the Final EIS.

With respect to model predictions compared to data from other existing nearby pit lakes, please see the response to comment 11-35.

11-38 Because of the uncertainty associated with water quality predictions, as well as some of the risk assessment assumptions, there is undoubtedly substantial variation in the risk estimates. It is for that reason that conservative factors were incorporated into the risk assessments, including 100 percent bioavailability and 100 percent food and water intake from the pit lake. Please see the response to comment 2-14 regarding monitoring pit lake water quality, and see both the response to comment 1-54 and Attachment C1 to Appendix C of the Final EIS for a more detailed explanation of the assumptions and processes used for both the screening-level and baseline risk assessments in determining that the future pit lake water quality would not adversely affect wildlife.

11-39 Please see the response to comment 11-8 regarding the potential for ground water outflow from the pit.

11-40 Please see the response to comment 2-14 regarding the results of the ecological risk assessment. Please see the response to comment 11-2 regarding pit backfilling.

Letter 11 Continued

9. **Reinfiltration of contaminanted water**

11-41 The DEIS indicates that water is being reinfiltrated to groundwater with antimony concentrations (0.039 mg/L) that exceed drinking water concentrations by over a factor of 6. We are very concerned that there have been no data collected on background water concentrations of antimony under the infiltration basins. The burden of proof that groundwater is not being contaminated should rest with the mining proponent. The BLM should require a groundwater monitoring program be established as part of the decision. Even though it is not required in the discharge permit, the decision on this mine should require monitoring of antimony, since it is a violation of Nevada regulations to contaminante groundwater.

10. **Ecological Risk Assessment**

Ecological risk assessments often use large extrapolations to estimate potential problems for wildlife. When those extrapolations also are further complicated by entirely untested pit lake water quality models, the reliability of these estimates is sufficiently poor that they effectively have no regulatory utility. But for the moment, we shall assume that the pit lake predictions are acceptable and examine the data used for risk estimates for the little brown myotis.

11-42 The issue of concern regards antimony. This is a very toxic element, and is in the same periodic table group as arsenic. It also appears to have some of the same symptoms and toxic effects as arsenic, in that it affects respiration and glucose metabolism. (See, for example, Cararett and Doull's Toxicology, by Doull, Klaassen and Amdur, 2nd ed. 1980). Because of the close similarity, these two elements should not be considered independently in any toxicological assessment, since they almost certainly have similar mechanisms of action. In the absense of information to the contrary, the toxicity of these elements should be considered as additive, and the risk assessment should reflect that additive effect. It does not appear that this was the case.

11-43 In the screening level assessment, data were used for the no-observed-adverse-affect (NOAEL) based on a rat study, which gave a NOAEL level of 0.035 mg/kg/day dose. However, for some unknown reason, the contractors who performed the baseline risk assessment then used a different study on ewes and lambs which gave a NOAEL of 2 mg/kg/day dose, which is different by a actor of 57. With the new NOAEL, the antimony issue went away, primarily because of the selection of data set used for establishing the NOAEL. The DEIS presented no rationale for the change or even referenced the original sheep study used to develop the risk assessment. Although only one criteria for selection of model animals, if one compares the size of rats and bats and sheep, one would suggest that rats were a better model. Unless there is some other reason for using sheep as a model for bats (i.e. metabolic), the data from the rat study should be used, rather than the sheep study. This may seem like a small point, but permitting of this pit lake can hinge on which analog study was used for risk assessment on bats. Use of the 0.035 mg/kg/day value in the baseline assessment will generate a Hazard Quotient above 10.

Response to Letter 11

11-41 As stated in the Draft EIS, monitoring antimony concentrations in either the mine discharge to the reinfiltration basins or in the monitoring wells in the vicinity of the reinfiltration basins was not required under SFPG's Groundwater Protection Permit. Since the Draft EIS was completed, SFPG directed its analytical laboratory to determine antimony concentrations on all samples stored in the laboratory (and still within its allowable holding limits) from monitoring wells located in the vicinity of the reinfiltration basins. The results of these analyses have been added to Table A-2 in Appendix A of the Final EIS. The results of the analyses indicate that the concentrations of antimony in the alluvium for the reinfiltration basin monitoring wells were below the detection limit of 0.002 milligram per liter. Section 3.2 of the Final EIS has been revised to incorporate this new information, as well as a revised discussion of potential impacts to ground water. In addition, mitigation measure WR-8 in Section 3.2.4 of the Final EIS addresses monitoring and mitigation of antimony in the reinfiltration basin water.

11-42 Additivity in acute toxicity is better understood than additivity in chronic toxicity, and assumptions for one may not hold true for the other; this may be caused by changes in the chemical's mechanisms of action. Toxicity of chemical mixtures may reflect the contributions of multiple constituents. This additivity may be accounted for by summing hazard quotients of greater than 0.3 if (1) at least one chemical hazard quotient exceeds 1.0 and (2) the mechanisms of toxic action of this chemical are similar to the mechanisms of toxic action of chemicals with hazard quotients greater than 0.3 but less than 1.0. This policy avoids measuring a plethora of chemicals until the sum of the hazard quotients is greater than 1.0 even though individual hazard quotients may be very low.

It is true that if the above-mentioned criteria regarding hazard quotients are met, it may be appropriate to sum hazard quotients. However, identifying the mode of action is a complex matter and involves expert, sometimes subjective, judgment. In addition, there is conflicting experimental evidence regarding interactions of metals. Broad generalizations regarding metal toxicity cannot be made. Some investigations have indicated that, with any group of metals, additivity

may occur for some combinations of metals, but synergism or antagonism may occur for other combinations. Differences can also be apparent between acute and chronic exposures.

In response to the comment, a detailed discussion on potential additivity is presented in Attachment C3 to Appendix C of the Final EIS. None of the hazard quotients calculated in the baseline risk assessment for arsenic or antimony was 1 (Parametrix 1996). Additionally, no evidence was found in a search of the scientific literature for similar modes of action for arsenic and antimony. Consequently, applying the policy outlined above and in Attachment C3, additivity was not assumed in the assessment of risk for these two elements.

11-43 Please see the response to comment 1-54 in addition to Attachment C1 to Appendix C of the Final EIS for additional information on the processes and assumptions used in the ecological risk assessment.

Letter 11 Continued

11-44 In fact, the use of sheep as a model for bats is sufficiently alarming that it brings into question the entire risk assessment study. It appears to be an apologetic for the mine proponent and a contorted use of science to massage and manipulate numbers around to satisfy the need of the mining proponent to move the project forward. In this regard, we request information on the process for selection of this contractor. Did the BLM select this organization to perform the study. Did the EIS coordinator *independently* select the contractor? Or did the mine proponent select the contractor and pay them directly for this study? Did the mine proponent have anything to do with selection of the risk assessment contractor.

Since this issue appears to be the only regulatory handle the BLM has on the permitting of the pit lake (other than groundwater contamination), it would appear to be reasonable to expect that the study on ecological risk assessment should be performed by a group that does not report directly to the company being regulated. We have no knowledge that this was the case for the Twin Creeks mine, but other BLM permitting processes have allowed this blatant conflict of interest to occur. If such a conflict of interest has occurred, further discussions are necessary to determine whether the risk assessment needs to be re-examined.

Thank you for the opportunity to provide these comments.

Sincerely,

Glenn C. Miller, Ph.D. Chair of the Mining Committee
Toiyabe Chapter of the Sierra Club

Tom Myers, Ph.D.
Hydrologic consultant to
Great Basin Mine Watch

Response to Letter 11

11-44 The ecological risk assessment was conducted by Parametrix, Inc. under contract to SFPG. The third-party EIS process allows the applicant to conduct baseline studies and evaluations. It is the responsibility of the lead agency and its EIS contractor to independently review and verify these studies before they are incorporated into the EIS. In this case, the ecological risk assessment methodology and results were reviewed and verified by a toxicologist on the EIS contractor's team.

It should also be noted that the BLM, and other agencies where applicable, participated in scoping and reviewing studies throughout the preparation of the EIS. For example, in the case of the ecological risk assessment, representatives of the BLM, U.S. Fish and Wildlife Service, Nevada Division of Wildlife, and Nevada Division of Environmental Protection reviewed the scope of work, attended review meetings, and reviewed the technical report before the results were included in the EIS. This review process was also implemented for the ground water hydrology and geochemical pit lake modeling results.

Please also see the response to comment 11-9.

Letter 12

Comments on the Twin Creeks Mine Proposal
Tom Myers, Ph.d.
Hydrologic Consultant, Great Basin Mine Watch

Thank you for this opportunity to present testimony on the Twin Creeks EIS. I have only begun my detailed review and will offer fairly general comments tonight followed by specific comments by the deadline.

First, Great Basin Mine Watch is a coalition of independent miners, ranchers, Native Americans, and environmentalists formed two years ago to watchdog large mining projects. I am hydrologic consultant for the group.

Second, I will point out that this NEPA document exceeds in quality many other EISs I have read. This EIS actually provides numbers, such as pit lake volume, that documents for other mines left out and which I had to calculate. The quality of NEPA documents has improved with succeeding mining proposals, but is still far from perfect. My primary interest is hydrology and still find the document lacking
12-1 in hydrologic detail. Specifically, detailed designs of the bypass channels are discussed but designs are not provided. Or, the detail of groundwater modeling is also lacking. I realize that a separate document is available, and I am reviewing it, detailing the models and probably the designs, but I also feel that two or three additional pages of detail in the EIS would make the NEPA documents much more complete.

But the additional detail in this EIS shows that this mine has potential impacts in the Humboldt River watershed exceeded only by Lone Tree. I offer these few specific comments and will provide more detailed comments in by the September 3 deadline. I have not finished reviewing the EIS in complete detail.

12-2 1. This project will divert perennial and ephemeral stream channels. I saw no reference to required Clean Water Act permits for fill in waters of the United States. At the very least, a Nationwide 26 permit is required for fill in the floodplain of the waters of the United States. Quite possibly, due to the length of streams diverted, impacts will exceed minimal and 404b permit will be required where alternatives must be considered and the least environmentally damaging possible alternative must be identified. Basically, the chemical, physical and biologic integrity of the

C:\office\wpwin\wpdocs\twincks1.wpd

Response to Letter 12

12-1 Details regarding the diversion design are summarized in Section 2.4.7.1 of the Final EIS. Also, please see the response to comment 1-24 regarding design features of the diversion structures. Details of the ground water model are discussed in the response to comment 11-23.

12-2 Please see the response to comment 1-29.

Letter 12 Continued

12-2 waters of the United States must be retained. This EIS fails to adequately address these requirements.

12-3 2. The Rabbit Creek diversion, by decreasing gradient, will lead to a braided channel. Aggradation will occur because the channel will try to reach a gradient necessary for sediment transport. When a large flow occur, the high stream power will cause a knickpoint and incised channel to form which will then migrate upstream destroying most of the riparian vegetation and causing localized groundwater level decreases.

12-4 3. Pit dewatering and excavation will result in a massive groundwater deficit in the local basin and add to the overall deficit in the Humboldt River basin. The No-Action alternative, which is continued mining for four years, calls for the dewatering of about 40,000 acre-feet of water over the next four years. This is about the volume of the drawdown cone around the mine based on figures in the EIS. While reference is made to reinfiltration, most of the dewatering is consumptively used for mining and milling. There is also a minimum amount discharged to Rabbit Creek, but I presume much of it infiltrates. Because it represents wetting of previously dry soil, it does not recharge the groundwater, but is essentially bound in the unsaturated zone or evapotranspired. The open pit will have about 130,000 acre-feet, which is also a deficit to the basin. The existing project, corresponding to the No Action alternative, represents a deficit of near 170,000 acre-feet.

12-5 Pumping in the Proposed Action consists of an additional 200,000 acre-feet of dewatering which appears to be near the volume of the drawdown cone. The pit will have a volume of 460,000 acre-feet. Therefore this total deficit due to this mine is about 660,000 acre-feet, or an additional 470,000 acre-feet over the current mine. I would add that predictions of pumping rates as this project excavates deeper and deeper become dubious because the pit intersects more bedrock; water developed within due to fractures and the like is more difficult to predict. Predictions of dewatering rates have been quite wrong in the past at other mines and becomes much more uncertain at deep drawdowns such as this mine. Certainly, this project leads to groundwater mining which is in opposition to Nevada State water policy.

12-6 I also note that discussion of reinfiltration in the proposed action is very nebulous. I am uncertain whether the same plan as for the No Action alternative will be used,

Response to Letter 12

12-3 Please see the response to comment 11-20.

12-4 Please see the response to comment 11-25.

12-5 Please see the response to comment 11-26.

12-6 Please see the response to comment 11-30.

Letter 12 Continued

12-6 additional basins will be constructed, or, as is implied at certain points, no reinfiltration will be used.

12-7 The EIS predicts that the baseflow in the Little Humboldt River will decrease by up to 20 %. This river is over six miles away. The report does not address impact on the Humboldt River itself. (Or if it does, I haven't yet found it yet.) Based on the continued growth of the drawdown cone while the pit lake fills, it is likely that most flow in the several streams draining south from the Osgood and Snowstorm mountains will go to fill the deficit. I refer to Evans, Rabbit and Kelly Creek. Chimney Creek, draining north, will also likely go dry.

Approval of this project basically assures that most surface water sources and riparian areas within the local basin will dry in the long run. And I wouldn't want to own a well in the Rabbit Creek basin.

12-8 4. The overall Humboldt River basin deficit after mining ceases, based on currently operating and proposed mines, is now about 4,000,000 acre-feet, of which 660,000 acre-feet is due to this proposal. This is about a 75% increase since my original survey of the issue three years ago. It includes both the volumes in drawdown cones and the pits. It represents about 40 percent of the overall water quantity stored in the Humboldt River basin upstream from Winnemucca. Because it is currently unknown how the recharge of this volume will affect flows in the Humboldt River, the impacts of the reductions of flow on downstream surface water rights in Lovelock or the wells providing municipal water for Winnemucca is unknown. It is an issue that the Geological Survey is considering in a nine-year study and an issue that we at Great Basin Mine Watch are interested in and will be considering over the next two years. We'll let you know of our results.

But, to put it in perspective, the annual flow past the city of Winnemucca in both surface and groundwater is about 160,000 acre-feet per year. If all of the flow in the river, surface and ground water, went to make up the deficits created upstream from the city, it would take 25 years.

Because of the uncertainty and potential massive impacts associated with a lack of knowledge of the impacts to the Humboldt River, a prudent person would forgo approval of additional mining projects within the basin until answers are forthcoming. Downstream water right holders should request as much. The

C:\office\wpwin\wpdocs\twincks1.wpd

Response to Letter 12

12-7 Please see the response to comment 11-29.

12-8 Please see the response to comment 11-32.

Letter 12 Continued

12-8 decreased flows and lowers groundwater tables have economic and environmental impacts far beyond that suggested by this document.

Thank you.

C:\office\wpwin\wpdocs\twincks1.wpd

Response to Letter 12

Letter 13

LASER, INC.
LEGAL AND SAFETY EMPLOYER RESEARCH
AN INDEPENDENT INDUSTRIAL HEALTH DIVISION OF THE WESTERN STATES PIPE TRADES
1400 Highway 99, Suite F, Gridley, CA 95948 (P) 916/846-6352 (F) 916/846-6274

BLM--WINNEMUCCA DISTRICT OFFICE
ATTN--GERALD MORITZ
BY FAX
9/3/96

Dear Mr. Moritz:

LASER reviews large industrial projects in the West, on behalf of its many members and supporters, who live and work in the West, including the vicinity of the proposed Twin Creeks Mine. Here are LASER's comments on this Mine. Please send LASER a copy of the FEIS and the Record of Decision.

Yours,

Jim Wilson
cc: Linda Williams, attorney
David Rosenfeld, attorney

Letter 13 Continued

2

LASER'S COMMENTS ON THE TWIN CREEKS MINE EIS

QUESTIONS ABOUT NEPA STATUS

13-1 The proposed action included development of reinfiltration basins (2-19). But published accounts indicate that the reinfiltration basins are already in place. The FEIS should clarify what developments the Mine is entitled to undertake before this NEPA process is completed. If the infiltration basins are already permitted, please state when that NEPA approval took place.

POTENTIAL FUTURE DEVELOPMENT NOT DESCRIBED

13-2 In the DEIS section on "reasonably foreseeable cumulative impacts," Table 2-11 does not apparently list the development of the Rosebud Mine west of Winnemucca, from which ore will be transported to the Twin Creeks mine for processing. If ore from this mine will be processed at Twin Creek, than those related impacts should have been described. If the mine wastes from processing of this ore will be disposed of within the Twin Creeks Mine area, then an analysis of those potential impacts should have been included in this DEIS.

OPEN PIT

13-3 After mine closure, a suggested mitigation of blending the waste rocks does not deal with the problems of ARD a 2171 acre open pit will apparently be left. This will cause several unmitigated impacts, that could be reasonably mitigated.

OPEN PIT IMPACTS--LOSS OF SURFACE AREA

13-4 The exposed pit walls may yield polluted leachate that will pool in the pit. Those pollutants may be concentrated by evaporation. That polluted pit water could threaten animal life and ground water quality.

13-5 Leaving the open pit reduces the amounts of surface area that could otherwise be reclaimed, by approximately 2000 acres. This reduction in reclaimed area is a significant and adverse impact that could be reasonably mitigated, either by filling the pit, or by requiring the Mine owner to acquire and improve other lands to create or restore rangelands, animal habitat, and grazing areas.

GROUNDWATER LOSSES

13-6 The pit will fill up with groundwater after the mine's closure. This will reduce groundwater recharge of surface water bodies and springs, and could affect irrigation wells. This impact on surface waters will also reduce animal habitat, in addition to the losses of almost 2200 acres of surface area to the unreclaimed open pit.

ALTERNATIVE OF FULLY BACKFILLING THE PIT

13-7 Backfilling of the South Pit, or all the Pits, should be discussed in the FEIS and it should be made a feature of the Record of Decision and the Plan of Operation. This would increase the amount of reclaimed surface area, it would reduce the possibility of creating a pit pool - tainted

Response to Letter 13

13-1 Please see the response to comment 11-30 regarding the reinfiltration basins. The existing reinfiltration basins are located on private land; therefore, they are not subject to analysis under the National Environmental Policy Act. The existing reinfiltration basins were permitted under the authority of the Nevada Division of Environmental Protection.

13-2 At the time the Draft EIS was written, SFPG had not finalized an agreement with Hecla Mining Company regarding the Rosebud Mine. As described in Section 2.4.4.6 of the Final EIS, SFPG and Hecla have formed a joint venture to develop the Rosebud Mine. The Rosebud ore would be hauled to the Twin Creeks Mine for processing.

With respect to the potential impacts from the placement of tailings generated through the processing of ore from the Rosebud Mine, Section 3.2.2.3 (Mill and Tailings Facilities subsection) has been revised to include a discussion of the different tailings materials, and address potential impacts to water quality associated with the applicable tailings facilities. In addition, the source and destination of the tailings materials are summarized in Section 2.4.4 of the Final EIS.

13-3 Please see the responses to comments 1-20 and 2-9, and Section 3.2.2 of the Final EIS regarding acid rock drainage from surface placement of overburden and interburden material.

The predicted impacts of the pit lake on ground water and ecological resources comprise an important part of the EIS analysis. Studies designed to quantify the impacts are listed below (also on page 3-1 of the Draft EIS):

- Hydrogeologic Framework and Numerical Ground-Water Flow Modeling of the Region Surrounding the Twin Creeks Mine, Humboldt County, Nevada (HCI 1996a)
- Predicted Water Quality in the Twin Creeks Mine Pit Lakes (PTI 1996)
- Ecological and Human Health Risk Assessments of the Future

Response to Letter 13

Pit Lakes: Twin Creeks Mine, Golconda, Nevada (Parametrix, Inc. 1996)

These studies are summarized in Sections 3.2, 3.5, and Appendix C of the Draft and Final EIS.

13-4 Evaporation, precipitation, and metals concentrations were considered during the pit water quality study and the ecological risk assessment. Assessing future pit lake water quality and the potential effects to wildlife resources and ground water were the primary reasons for conducting the ecological risk assessment. See the response to comment 2-14 for information pertaining to pit lake water quality.

13-5 The BLM does not believe the loss of vegetation, soils, or wildlife habitat associated with the open pit is a significant impact. Historically, this area has never been recognized as containing significant vegetative and wildlife habitat compared to what is found in the surrounding upper elevations and upper drainages. In addition, this immediate area has experienced numerous wildland fires, which have significantly altered the cover. The entire mine site was burned in a 1985 range fire. In September 1996, a considerable amount of the Twin Creeks project area and a large area surrounding the mine site were again burned. As a result of the recent fire SFPG, in cooperation with the BLM, committed resources toward rehabilitating suitable portions of the burned area in an effort to restore some of the rangeland, wildlife habitat, and grazing areas.

13-6 Impacts to perennial surface waters, including potential reductions in flow and potential impacts to irrigation wells, were addressed in Section 3.2.2 of the Draft EIS. Impacts to wildlife habitat from changes in water resources were addressed in Section 3.5.2 of the Draft EIS.

13-7 Please see the response to comment 11-2 for a discussion of pit backfilling.

Letter 13 Continued

3

13-7 water, and it would reduce the groundwater and surface water impacts from the filling of the pit with groundwater after mine closure.

AIRBORNE ARSENIC

The ground surface of some of the proposed mining facilities areas to be disturbed contain arsenic. Activity at these locations could cause this arsenic to become airborne, and that will pose a potential health risk that was never analyzed in the DEIS. A 1990 report by the California Air Resources Board (CARB) identified windblown dusts as potential "hot spots" of arsenic emissions. This type of dust is a potential emissions during surface development in the arsenic contaminated portions of this mine.

13-8 The 1990 CARB report identified airborne arsenic as strongly associated with respiratory cancer, and as genotoxic, as inducing chromosomal aberrations, and sister chromatid exchange, and inhibition of DNA repair. An exposure of just a few nanograms per cubic meter of arsenic can induce excess cancer deaths among exposed populations. The CARB proposed identification of arsenic as a toxic air contaminant and a probable carcinogen.

The DEIS should have predicted the levels of arsenic exposure among mine workers and nearby population from this Mine activity on arsenic contaminated lands. The alternative of avoiding these areas should have been considered in the DEIS.

ADDITIONAL CONCERNS

13-9 LASER is also concerned about the Mine's past and potential future use of out of state construction crews, which will cause additional socio-economic impacts on the surrounding communities.

13-10 LASER urges the BLM to reject the use of non-native plantings during reclamation, and
13-11 to require the paving of main haul roads to reduce dust at the mine.

13-12 LASER also believes that the final walls of the reclaimed mine features may be too steep,
13-13 that any degraded wet lands and riparian areas should be mitigated by creation or enhancement of
13-14 other similar areas, and that the Mine's past water and air quality violations should have been discussed in the EIS.

13-15 LASER joins in, and supports the fuller discussions of these topics by other commentors, including the Building Trades Council of Northern Nevada.

13-16 Regarding the geology of the mining area, and the engineering of the mining features, the DEIS should have discussed the causes of the pit wall slide at this mine in 1994.

Response to Letter 13

13-8 As part of the proposed Twin Creeks Mine expansion, a permit would be obtained from the Nevada Division of Environmental Protection, Bureau of Air Quality, for disturbance exceeding 5 acres. As stipulated in the permit, fugitive dust must be controlled on all surface disturbance sites. SFPG would control fugitive dust through appropriate site watering before and during disturbance activities. If necessary, additional chemical surfactant would be used to ensure that dust containing arsenic would not blow about in the wind during construction and operation.

13-9 Comment noted. The percent of non-local construction workers used in the EIS analysis is based on past trends, existing workforce demographics, and estimated availability of local construction workers. The availability of local workers would depend on the timing and construction schedules of other projects in the area.

13-10 Please see the response to comment 2-7 regarding the use of native plant species during reclamation.

13-11 SFPG would use water sprays or other measures to reduce fugitive dust emissions in compliance with the surface disturbance permit issued by the Nevada Division of Environmental Protection. The air quality analysis for the EIS did not identify any potentially adverse air quality impacts from dust emissions that would necessitate paving the haul roads.

13-12 The stability of the mine components was addressed in Section 3.1.2 of the Draft EIS.

13-13 Please see the response to comment 2-1 relative to wetland and riparian area mitigation.

13-14 Past water quality exceedances for the Twin Creeks Mine were summarized on page 3-44 of the Draft EIS (Section 3.2.1) and in Appendix A, Tables A-3 and A-4.

The Twin Creeks Mine has received three notices of violations for air and water, all of which occurred in 1994. The first, in March, was an

air quality permit violation for throughput limit exceedances. The notice of violation was issued as a warning, and no fine was levied. The second, in April, was a Water Pollution Control permit violation for a leaking pipe, an acid leak from a storage tank, petroleum-contaminated water in an unlined pond, and a leaking tailings booster pump. Corrective actions were taken to remedy the problems, and no fine was levied. The third, in July, was a National Pollutant Discharge Elimination System permit violation for discharging sodium cyanide without authorization. There was no environmental health impact from the violation since it was below the water quality standard for cyanide; the resulting fine was $7,000.

13-15 Comment noted.

13-16 A description of the failure of part of the west central portion of the pit wall on December 26, 1994, has been added to Section 3.1.1 of the Final EIS.

Letter 14

The SHOSHONE-BANNOCK TRIBES

FORT HALL INDIAN RESERVATION
PHONE (208) 238-3700
(208) 785-2080
FAX # (208) 237-0797

FORT HALL BUSINESS COUNCIL
P. O. BOX 306
FORT HALL, IDAHO 83203

September 5, 1996

Mr. Ron Wenker
District Manager
United States Bureau of Land Management
Winnemucca District
5110 E. Winnemucca Blvd.
Winnemucca, Nevada 89445

RE: COMMENTS ON THE DRAFT EIS & SHOSHONI MIKE MASSACRE SITE

Dear Mr. Wenker:

The Shoshone Bannock Tribes of Fort Hall, Idaho, welcome the opportunity to provide formal comment on the Draft Environmental Impact Statement, concerning the proposed expansion of the Santa Fe Pacific Gold Company, due on September 20, 1996.

14-1 The Tribes would like to conditionally support the modifications of the permitted action in Section 25, located on private land, contingent on Santa Fe Pacific Gold acquiring ownership of, or permission to, use the land.

14-2 It is our understanding that this section of land is private and now owned by First Miss Gold (Getchell Mines) and that Santa Fe Pacific Gold has been in negotiations to purchase the section for a waste dump. It is listed in the DEIS as such under the no action alternative, meaning the BLM does not control activities on that section. Since the negotiations are not final, Santa Fe does not control activities in Section 25 either. The Shoshone-Bannock Tribes would like to be informed of who controls activities on this land. If negotiations between Santa Fe Pacific Gold and First Miss Gold Co. (Getchell Gold) does not conclude with Santa Fe Pacific Gold acquiring the land, we would appreciate initiation of negotiations with whoever controls the land and area around the Shoshoni Mike Massacre/ burial site.

14-3 The Tribes would also like a final determination on whether this action is considered inside the federal undertaking area. This is because of the possibility that the Nevada Division of Environmental Protection permit received may be federally funded through the Environmental Protection Agency (EPA), and that there may be some federal involvement on those permits.

Response to Letter 14

14-1 Comment noted.

14-2 SFPG is negotiating with Getchell Gold Corporation for the use of this land. BLM will assist the Shoshone-Bannock in making contact with Getchell Gold Corporation; however, unless Getchell Gold Corporation proposes an action that requires BLM approval, BLM has no authority to restrict activity on the privately owned land.

14-3 Nevada Division of Environmental Protection actions are not federal undertakings. The currently permitted activities at the Twin Creeks Mine were evaluated as the No Action alternative in the EIS.

Letter 14 Continued

Page Two
RE: DEIS Comments
Shoshone Mike

base of the planned waste dump to avoid the Shoshoni Mike marker, draw area, and trail, leading to the location where a massacre and mass burial took place.

14-4 A letter dated, August 22, 1996, (NV-245) states, "the base will be moved far enough back from the edge of the draw to ensure that water running down the slopes of the waste pile will not cause erosion in the draw where the marker is located." The Tribes desires written assurance from BLM and Santa Fe Pacific Gold, that these changes are to be final, and that no additional changes or revisions are to occur without the Tribes consent. We also ask that no further mining expansions and/ or activities affect Section 25. In addition the Tribes recommend that the Shoshone Mike trail be identified, evaluated, and recommended for historic preservation and copies of the nomination be forwarded to the Tribes. Santa Fe Pacific Gold has offered to erect a monument in recognition of Shoshone Mike. The passage to be written on the marker will be discussed with other tribes involved in this matter, and reported to Santa Fe Pacific Gold.

14-5 Section 3.8.2 of the DEIS indicates that direct physical impacts to cultural resources could occur during ground disturbing activities associated with the construction of the new facilities and reclamation activities around the existing mine. Indirect impacts could result from increased erosion or improved access, which makes sites more vunerable to accidental or deliberate disturbance and illegal collecting. The Tribes would like assurance from Santa Fe Pacific Gold that all safeguards and precautions available, can and will, be used to protect the cultural resources present from the physical and indirect impacts listed above. We also request that any individual or group of individuals initiating or participating in these illegal activities be prosecuted to the fullest extent of the law. Including, but not limited to the Archaeological Resources Protection Act, as amended (ARPA).

14-6 Sections 3.8.2.1 and section 3.8.2.2 of the DEIS identifies that sites would be impacted by the construction of overburden and interburden storage areas. The Tribes would like these areas to be minimized, so that the impacts be small , or totally avoided, if at all possible.

14-7 The Shoshone Bannock Tribes are willing to enter into an Memorandum Of Understanding (MOU) on matters of interest to the Tribes, BLM, and Santa Fe Pacific Gold. This can be accompsished in negotiation and discussion with our legal staff initiated through the Heritage Tribal Office and Cultural Resources. We are also requesting that Indian Tribes be notified immediately if human remains, and/or funerary items are discovered on *public or private* land controlled by BLM or Santa Fe Pacific Gold. We request consultation occur in accordance with the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) , the Nevada State Burial Law, and any other applicable laws. The Shoshone-Bannock Tribes request to be among the Tribes notified.

14-8 Section 3.4 of the DEIS identifies the natural vegetation that will be disturbed. We would encourage that only natural vegetation be replanted into the area, and strongly discourage any non native plants being distributed in this area. Santa Fe Pacific Gold must commit to the Tribes that a reclamation process will include as much of the surrounding natural vegetation as can be used. We would hope that at the end of the reclamation process, the integrity of the site be restored to as close to the natural state as possible.

14-9 The Shoshone-Bannock Tribes would like to thank Santa Fe Pacific Gold Company for the

Response to Letter 14

14-4 Please refer to mitigation measures CR-1 and CR-2 in Section 3.8.4 of the Final EIS regarding the Shoshone Mike Massacre site.

The BLM has no authority to restrict activity on privately owned land unless it is associated with activity on publicly owned land. However, if the BLM should review any proposals for work on adjacent publicly owned sections, the BLM would take into account the Tribes' concern for protecting Section 25.

Please see mitigation measure CR-3 in Section 3.8.4 of the Final EIS regarding collecting and preserving information associated with the Shoshone Mike Massacre.

Please see mitigation measure CR-2 in Section 3.8.4 of the Final EIS regarding the Shoshone Mike commemorative marker.

14-5 Please see the response to comment 14-4.

14-6 Please see the response to comment 14-4.

14-7 Please see mitigation measures CR-4 and CR-6 in Section 3.8.4 of the Final EIS regarding potential human remains.

14-8 Please see mitigation measure CR-5 in section 3.8.4 of the Final EIS regarding the inclusion of native plant species for revegetation.

14-9 Comment noted.

Letter 14 Continued

Page Three
DEIS Comments
Shoshone-Mike

14-9 cooperation exhibited in this process. The fact that the section of land in question is private does not remove our traditional respect for our deceased ancestors. Although we would like to see the entire area protected and, we are sure, that Santa Fe Pacific Gold would like to use the entire area. By reaching a compromise, the Tribes are sure we can each have an agreement that is workable.

14-10 If all the above conditions can be met, we agree to the proposed action. If anything needs further discussion, or we have inadvertently left something out, please feel free to contact the Tribes through the Heritage Tribal Office/ Cultural Resources Program at the address indicated on our letterhead, or at (208) 238-3706 and we will gladly see if something can be worked out.

The Tribes offer our thanks for providing an extension in the comment period. We look forward to continued cooperative efforts in the future. Thank you.

Sincerely,

Delbert Farmer
Chairman, Fort Hall Business Council

cc: HeTO/CR
Tribal Attorney: A. Jones
chrony

Response to Letter 14

14-10 Comment noted.

Letter 15

Document Submitted by: Jack C. Orr, Chairman
Western Shoshone Resources Inc.
P.O. Box 21479
Reno, Nevada 89515-1479
phone/fax (702) 324-5899

Received
SEP 23 1996
Land Management
Winnemucca District

Researched and Prepared by: Western Shoshone Defense Project
P.O. Box 211106
Crescent Valley, Nevada 89821
phone (702) 468-0230, fax (702) 468-0237

Comments on the Draft Environmental Impact Statement

of Santa Fe Pacific Gold Corporation's

TWIN CREEKS MINE

BLM Winnemucca District

15-1 The following pages represent our comments concerning the Twin Creeks Mine Draft Environmental Impact Statement. Our evaluation of this document has lead us to the conclusion that the said document is inadequate in the analysis of the potential impacts of this project. As such it does not provide the public with adequate information to judge the impacts of this project. Our recommendation is that this document be redone with additional information to address the issues and concerns expressed in these comments. Based upon the information in our possession, the Twin Creeks Mine would create unacceptable environmental and cultural impacts on the Western Shoshone Nation. We oppose the construction of this project as it is now proposed.

The Treaty of Ruby Valley and Western Shoshone Sovereignty Issues

It should first be noted that the area potentially impacted by this project is located along the western boundary of the Western Shoshone Nation, as recognized by the U.S. government in the 1863 Treaty of Ruby Valley. These lands have been and continue to be used by both Paiute and Shoshone people, and constitute a joint use area. Nothing in these comments should be construed as denying the Paiute people their rights and responsibilities towards their lands.

15-2 The Treaty of Ruby Valley has not been discussed in this DEIS. The U.S. Constitution says that treaties are the supreme law of the land, not the 1872 Mining Law or the other federal regulations to which the DEIS makes reference. The 1863 Treaty of Ruby Valley between the U.S. and the sovereign Western Shoshone Nation has never been superseded by any legal means. Therefore, the lands which the Treaty affirms as belonging to the Western Shoshone Nation are still under their jurisdiction. Western Shoshone have often made this objection to BLM actions. The response of the BLM, including most recently in the Record of Decision for the Cortez Pipeline Gold Mine, has been that the Treaty is outside the scope of the BLM's judgment. That may very well be so. That does not entitle the BLM to proceed with actions the legitimacy of which is in doubt. If

Response to Letter 15

15-1 Comment noted.

15-2 Information gathering from Native Americans was ongoing when the Draft EIS was issued. A discussion of the continuation of the consultation process and the Treaty of Ruby Valley has been included in Section 3.8.1.4 of the Final EIS.

Consideration of the issue of the Treaty of Ruby Valley has, for the purposes of this National Environmental Policy Act process, been foreclosed by judicial determination in *U.S. vs. Dann* 873 F. 2d 1189 1200 (1989) cert denied 493 U.S. 890 (1990).

Letter 15 Continued

15-2 necessary, the BLM must go to the highest level necessary to validate its authority and its actions. The DEIS does not take the Treaty of Ruby Valley into account in its management considerations, nor does it show that the Treaty has been legally abrogated. If the authority to do so is outside the BLM's jurisdiction, then the BLM does not have the authority to take the action suggested by the DEIS. NEPA requires that the lead agency invite all relevant agencies to participate in the NEPA process. As the Western Shoshone Nation is a sovereign nation, perhaps the U.S. State Department needs to be involved.

It should be noted that cash payment such as the Claims money, often made reference to by the U.S. government when discussing the land rights issues, does not nullify a Treaty. One does not buy or sell their inherent sovereign rights. The Treaty was a recognition of these rights by the U.S. In a nation to nation agreement, one nation cannot unilaterally decide that the other side has lost its nationhood, especially by offering money.

The current Draft **United Nations Declaration On The Rights of Indigenous Peoples**, which the U.S. is a party to, supports the claims of the Western Shoshone Nation. Articles 36, 30 and 26 are particularly relevant:

Article 36

Indigenous peoples have the right to the recognition, observance and enforcement of treaties, agreements and other constructive arrangements concluded with States or their successors, according to their original spirit and intent, and to have States honor and respect such treaties, agreements and other constructive arrangements. Conflicts and disputes which cannot otherwise be settled should be submitted to competent international bodies agreed to by all parties concerned.

Article 30

Indigenous peoples have the right to determine and develop priorities and strategies for the development or use of their lands, territories and other resources, including the right to require the States obtain their free and informed consent prior to the approval of any project affecting their lands, territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources. Pursuant to agreement with the indigenous peoples concerned, just and fair compensation shall be provided for any such activities and measures taken to mitigate adverse environmental, economic, social, cultural or spiritual impact.

Article 26

Indigenous peoples have the right to own, develop, control, and use the lands and territories, including the total environment of the lands, air, waters, coastal areas, sea-ice, flora and fauna and other resources which they have traditionally owned or otherwise occupied or used. This includes the right to the full recognition of their laws, traditions and customs, land-tenure systems and institutions for the development and management of resources, and the right to effective measures by the States to prevent any interference with, alienation of or encroachment upon these rights.

15-3 These articles in the U.N. Declaration support our contention that the Western Shoshone Nation has a sovereign right in determining which projects may occur within their traditional land base. U.S. and specifically BLM policy to this point in time has been in violation of these articles. The Twin Creeks DEIS is particularly deficient because it fails to address the issue of Western Shoshone land rights and the impact of this mine on "resources" of extreme importance to the continuing existence of the Western Shoshone Nation, i.e. water, plants and animals. The Western Shoshone Nation has not given its "free and informed consent" to this mining project. Fair compensation and mitigation as required by Article 30 of the U.N. Declaration has not been provided for the destruction of water resources in the Twin Creeks area.

Some confusion exists around the provisions in the Treaty of Ruby Valley which permit mining in Western Shoshone territory. The U.S. Supreme Court has ruled that treaties are to be interpreted as they were understood at the time of signing. This ruling is further reinforced by Article 36 of the U.N. Declaration which states that such treaties are to be recognized and enforced according to their original spirit and intent. In 1863

Response to Letter 15

15-3 Please see the response to comment 15-2.

mining was of an entirely different nature. The Western Shoshone in no way agreed to the scale, intensity, or form of modern open pit heap leach gold mining.

Included with these comments is a copy of a paper entitled "An Inquiry into the Rights of the Western Shoshone Nation" written by Steve Newcomb of the Indigenous Law Institute. We would like this included as part of our comments.

AN INQUIRY INTO THE RIGHTS OF THE WESTERN SHOSHONE NATION
by Steve Newcomb, Director, Indigenous Law Institute

Introduction

Mary, Carrie, and Clifford Dann continue to live under the constant threat of being forced off their lands by the federal government of the United States. The United States contends that the Danns and all other Western Shoshones have lost their land rights because of "gradual encroachment" by the dominant society. This novel and fraudulent fiction would have us believe that the Western Shoshones have no right of free consent. In other words, according to the federal government's view of reality, the Western Shoshones can be deprived of their lands against their will. It is clear that the United States is asserting a right of empire and dictatorial powers over the Western Shoshones under color of law. This means that while it may appear to be "law", it is simply a pretension on the part of the United States.

This behavior on the part of the United States is understandable given its origins. As George Washington wrote in 1786: "However unimportant America may be considered at present...there will assuredly come a day, when this country will have some weight in the scale of Empires...Altho' I pretend to no peculiar information respecting commercial affairs, nor any foresight into the scenes of futurity; yet as the member of an infant empire...I cannot help turning my attention to this subject..." (emphasis added) (Cited in Richard Van Alstyne's, The Rising American Empire, p. 69, 1960)

The Western Shoshones are under siege because the American Empire will stop at nothing to seize all Indian lands, and against the true law of this continent, which is Traditional Native Law. As the Congregational minister Jedediah Morse of Boston predicted in his book American Geography, in 1789, "it is well known that empire has been traveling from east to west. Probably her last and broadest seat will be America... We cannot but anticipate the period, as not far distant when the American Empire will comprehend millions of souls, west of the Mississippi." (Van Alstyne, Ibid.) It is this very empire that now threatens the Western Shoshones with genocidal dispossession. In our view, any discussion of Indigenous human rights must take place within the context of empire and domination, dating back to the time of Cristobal Colon (Columbus) and to the Inter Cetera papal bull of 1493.

The following inquiry is meant to pose a different line of thought than the one maintained by the U.S. federal government. What follows is only a tentative first step toward redefining the rights of Native and Indigenous First Nations. Please ask yourself, if George Washington's "infant empire", which is now full-grown, can deprive the Western Shoshones and other Native peoples of their lands and their liberty how do you know that you won't be next in line?

***Question*: What was the status of the Western Shoshone Nation when it made the Ruby Valley Treaty with the U.S.?**

Answer: Before the Ruby Valley Treaty, the Western Shoshones were "a people distinct from others," which is exactly how Chief Justice John Marshall defined the word "nation" in the U.S. Supreme Court ruling Worcester v. Georgia. A Marshall stated in Worcester:

> The term "nation", so generally applied, means "a people distinct from others." The constitution, by declaring treaties already made, as well as those to be made, to be the supreme law of the land, has adopted and sanctioned the previous treaties with the Indian nations, and, consequently, admits their rank among those powers who are capable of making treaties. The words "treaty" and "nation" are words of our own language, selected in our diplomatic and legislative proceedings by ourselves, having each a definite and well understood meaning. We have applied them to Indians as we have applied them to other nations of the earth. They are applied to all in the same sense. (emphasis added) (6 Peters, 559, 1832)

Thus, the words "nation" and "treaty" are to be applied to the Western Shoshone in the same way those terms are applied to the other nations of the earth. The Ruby Valley Treaty is an acknowledgment on the part of the U.S. that the Western Shoshone Nation is to be regarded as existing among "those powers who are capable of making treaties."

***Question:* Yes, but isn't there a major difference between a treaty which the U.S. makes with an Indian nation, and a treaty which it makes with nation-states?**

Answer: As a matter of fact this question was answered by the above quote from Worcester. But another case has also dealt with this question. In the case Turner v. American Baptist Missionary Union, a Michigan federal district court stated:

> It is contended that a treaty with an Indian tribe has not the same dignity or effect as a treaty with a foreign and independent nation. This distinction is not authorized by the constitution. Since the commencement of the government, treaties have been made with the Indians, and the treaty-making power has been exercised in making them. They are treaties within the meaning of the constitution, and as such are the supreme laws of the land.

When federal officials make the argument that the Ruby Valley treaty does not carry the same weight as a treaty which the U.S. has entered into with, say, France or Great Britain, they are making an argument that is "not authorized by the constitution."

***Question:* But how are we to know what rights the Western Shoshones had to their lands and their liberty when the Ruby Valley Treaty was made?**

Answer: According to the international law standards of the Christian Commonwealth, "the authority of a nation within its own territory is absolute and exclusive." (Church v. Hubbart, 2 Cranch, 187, 234). Since the word "nation" is correctly applied to the Western Shoshones, as it is correctly applied to any other nations on earth, the authority of the Western Shoshone Nation within its own territory was absolute and exclusive at the time it entered into the treaty of Ruby Valley with the United States and continues to be absolute and exclusive to this day.

With regard to the liberty of the Western Shoshones, in the case Johnson v. McIntosh (8 Wheaton, 543, 1823), Chief Justice John Marshall observed that it was "impossible to 'govern' the Indians 'as a distinct people.' Why? Because they were as brave and as high spirited as they were fierce, and were ready to repel by arms every attempt on their independence." Of the Louisiana purchase, Marshall observed that it was the purchase of a country that was already in the possession of Indian peoples "who are in fact independent."

Supreme Court Justice Joseph Story also commented on the independent spirit of the Indians. The Indians loved the fact that they were free and independent and fought courageously to defend their lands and their liberty. As Story noted in his Commentaries on the Constitution of the U.S.:

> There is no doubt, that the Indian tribes, inhabiting this continent at the time of its discovery, maintained a claim to the exclusive possession and occupancy of the territory within their respective limits, as sovereigns and absolute proprietors of the soil. They acknowledged no obedience, or allegiance or subordination to any foreign sovereign whatsoever, and as far as they have possessed the means, they have ever since asserted this plenary right of dominion, and yielded it up only when lost by the superior force of conquest, or transferred by a voluntary cession.

By looking at history in this manner can we understand what rights the Western Shoshone Nation had to their lands and their liberty at the time of the Ruby Valley Treaty. Clearly the Western Shoshones were "a people distinct from others," making them a "nation", but they were also a free and independent nation when they entered into that treaty of peace and friendship with the U. S. of America in 1863. When the Western Shoshones entered into that treaty, presumably it was to protect their lands and their liberty. To this day, the Western Shoshones have never freely agreed to give up their lands or their liberty.

***Question:* But I thought the courts of the U.S. held that the Western Shoshone lost their land rights due to "gradual encroachment"?**

Answer: As I have already explained, Indian people can not lose any of their rights to their liberty or their property without their free consent, and the Western Shoshones have never freely consented to relinquish their rights to their Western Shoshone Territory.

But let me approach your question in a different way. In 1787, the Continental Congress enacted what is known as the Northwest Ordinance, which states in part:

> The utmost good faith shall always be observed towards the Indians, their lands and liberty shall never be taken from them without consent; and in their property, rights, and liberty, they never shall be invaded or disturbed, unless in just and lawful wars authorized by Congress; but laws founded in justice and humanity shall from time to time be made, for preventing wrongs being done to them, and for preserving peace and friendship with them...(Journals of the Continental Congress, 32:340-41)

Now, let me ask you this, if the Western Shoshones were stripped of their lands by "gradual encroachment" weren't they also "invaded" and "disturbed" in "their property, rights and liberty" which the U.S. federal government forces the Western Shoshones to give up their lands against their will, aren't their "lands and liberty" being "taken from them without their consent."?

***Question:* Well, those are good questions from a rhetorical standpoint, but wasn't the provision you quoted from the Northwest Ordinance simply a kind of ceremonial statement rather than a declaration of policy? Besides, the Northwest Ordinance was written and enacted while the present Constitution for the U.S. of America was still being drafted. How do we even know the Northwest Ordinance is still binding on the U.S. by law?**

Answer: Since the early 1940's the Northwest Ordinance has been cited in court ruling 142 times. It is definitely still "valid law," having been reenacted into by the first Congress that was convened under the present Constitution. Indeed, the Northwest Ordinance has been referred to by the courts as part of "the basic organic law of the U.S." As such, principles set forth in the ordinance are foundational principles of the U.S., and therefore still very much operative and binding the federal government. They are principles by which the federal government bound itself.

But there is an additional piece of information that you are probably not aware of. In 1848, after the Treaty of Guadalupe Hidalgo between the U.S. and the United Mexican States, the U.S. Senate passed a resolution "to establish suitable Territorial governments for California, for Deseret, and for New Mexico." Additional language was then added to the resolution, securing "to the inhabitants of those territories all the privileges and liberties secured to the inhabitants of the Northwest Territory by the Ordinance of July 13, 1787." The territories referred to as "California" and "Deseret" included the Western Shoshone Territory.

When Congress passed "An Act to organize the Territory of Nevada" in 1861, the legislation was worded consistent with the Northwest Ordinance of 1787. The act establishing the Territory of Nevada reads in part:

> nothing in this act shall be construed to impair the rights of person or property pertaining to the Indians in said territory, so long as such rights shall remain unextinguished by treaty between the U.S. and such Indians, or to include any territory which, by treaty, with any Indian tribe is not without the consent of said tribe, to be included within the territorial limits, or jurisdiction of any state or territory; but all such territory (pertaining to the Indians) shall be excepted out of the boundaries, and constitute no part of the territory of Nevada, until said tribe shall signify their assent to the President of the U.S., to be included in said territory."

The above passage becomes all the more important in light of Section 16 of the Act establishing the Territory of Nevada: and be it further enacted, that the constitution and all laws of the U.S. which are not locally inapplicable, shall have the same force and effect within the said territory of Nevada as elsewhere within the U.S.

When Congress established the Territory of Nevada the Western Shoshone Territory was left out of the boundaries of the Nevada Territory. Congress acknowledged that the Western Shoshone lands would constitute "no part of the Territory of Nevada", until such time as the Indians should

Letter 15 Continued

freely consent, in a treaty with the U.S., to have their lands "included in the said territory". Furthermore, Section 16 quoted above says nothing about the constitution and laws of the U.S. having any force or effect within the boundaries of any Indian Territory, or over any Indian nation or people without the Indians' free consent.

What this means, then, is that the Western Shoshones' free and independent status as a nation can not be justly narrowed or extinguished against the will of the Western Shoshones, without free consent. To this day, the Western Shoshones continue to possess inherent fundamental rights to their lands and to their liberty by virtue of their existence as a distinct people, and a NATION. And none of their rights can be taken from them by any non-Western Shoshone government which would presume to govern them against their will.

This disqualifies the argument that the U.S. may unilaterally "extinguish" the territorial rights of the Western Shoshone Nation, or that the Western Shoshone lost their rights to their liberty and their territory based on "gradual encroachment." Such an extinguishment is not permissible pursuant to the Ruby Valley Treaty, which according to Article Six, section two, of the Constitution for the U.S. is the "supreme Law of the Land" of the U.S. of America and therefore binding on the whole nation.

***Question:* How do you know that the Treaty of Ruby Valley is binding on the United States?**

Answer: On April 13, 1787, the secretary for foreign affairs issued a letter to Congress for its consideration. If adopted, the letter was to be sent to the respective states regarding the subject of treaties. The letter was considered and unanimously agreed to by the Continental Congress.

The letter mentioned that Great Britain had complained of violations of the 1783 treaty of peace between Britain and the United States, and went on to advise the states as to the nature of treaties. As the letter stated:

> When therefore a treaty if constitutionally made, ratified and published by us (the Congress), it immediately becomes binding on the whole nation, and superadded to the laws of the land, without the intervention of the state legislatures. Treaties derive their obligation from being compacts between the sovereign of this and the sovereign of another nation. Hence it is clear, that treaties must be implicitly received and observed by every member of the nation. (Secret Journals of the Acts and Proceedings of Congress, From The First Meeting Thereof To The Constitution, By The Adoption Of The Constitution Of The United States, Vol. IV, p. 331, 1821)

Alexander Hamilton, in The Federalist Papers (no. 75), said that treaties are "CONTRACTS with foreign nations which have the force of law, but derive it from the obligations of good faith. They are not rules prescribed by the sovereign to the subject, but agreements between sovereign and sovereign."

In John Jay's opinion, treaties "are just as binding and just as far beyond the reach of legislative acts now as they will be at any future period, or under any form of government." Clearly, treaties formed pursuant to the new Constitution for the United States of America were also binding on the whole nation, and could not be unilaterally altered or amended by the United States without the consent of the other party to the treaty.

***Question:* Some people in the U.S. federal government contend that the Western Shoshone Nation is only a "domestic dependent nation: as articulated in the Supreme Court ruling Cherokee Nation v. Georgia 30 U.S. (5 Pet.) 1L. Ed. 25 (1831). Are they correct?**

Answer: No. Such U.S. government officials are mistaken. They probably do not understand the significance of the Ruby Valley Treaty. Such U.S. government officials have not considered that Chief Justice Marshall stated in Cherokee Nation, that Indians "may, more correctly, perhaps, be denominated domestic dependent nations." Besides an Indian treaty is to be interpreted as the Indians understood the treaty when it was made (Worcester v. Georgia). The only way for the "domestic dependent nation" argument to apply with regard to the Treaty of Ruby Valley is if it could be shown, which it cannot, that the Western Shoshones understood and agreed in the Treaty of Ruby Valley to allow themselves to be defined as a "domestic dependent nation."

***Question:* What about the argument that the Western Shoshone Nation only has a right of "aboriginal title" to its lands and territories? Is this a valid argument?**

Answer: It is not for the United States to define the land rights of Western Shoshones. The Western Shoshone Nation has the right to define its own land rights within its own territorial boundaries. The notions of "aboriginal title," "native title," "original Indian title," and so forth, were definitions created by the United States, and then unilaterally imposed on Native nations and peoples. Beginning with the premise that the term "nation" is properly applied to the Western Shoshones, it must therefore follow that the Western Shoshones also possess rights of territorial sovereignty, territorial integrity, as well as what Vattel termed the rights of "empire" and "domain". As Vattel pointed out:

> the general domain of the nation is full and absolute, since there exists no authority upon earth by which it can be limited: it therefore excludes all right on the part of foreigners. And as the right of a nation ought to be respected by all others, none can form any pretensions to the country which belongs to that nation, nor ought to dispose of it without her consent, any more than the things in the country. (Emmerich de Vattel, The Law of Nations, (1758), p. 164)

Because the Western Shoshone have the inherent right of the "general domain" over their territory, and because such a right of "domain" is "full and absolute," this "excludes all right on the part of" the United States. Therefore, the United States may not, based on any moral power, legitimately "form any pretensions to the country which belongs to" the Western Shoshone Nation.

Conclusion

According to the principles outlined above, we begin to get a more accurate picture of the Western Shoshone Nation's rights. The Western Shoshone were originally free and independent. They had the sole power of decision-making over their territory. They had the absolute right to keep others away from their lands, or else to allow visitors to come onto their lands only after having obtained permission. The Western Shoshones were "a

Letter 15 Continued

people distinct from others," which was how Chief Justice Marshall defined a "nation" in Worcester. But not only were the Western Shoshone a NATION, they were "in fact independent" at the time of Christian European contact.

This means that the Western Shoshone are rightfully entitled to remain a free and independent nation or people; their right to that status cannot be taken from them against their will. They cannot be legitimately deprived of their rights by any non-Western Shoshone nation or people. They cannot be deprived of their lands, or their rights if they are tricked into doing so by any artifice, fraud, or duress on the part of the non-Western Shoshone people.

Contrary to what it will assert, the United States has no legitimate or rightful authority over the Western Shoshone Nation. Furthermore, the United States Congress cannot legitimately "take" any portion of the Western Shoshone Nation's territory. Because the individual States never delegated to the federal government of the United States any power to "take" the lands of other nations or peoples (the States not having any such power to delegate), it must follow that there is nothing in the U.S. Constitution that could be construed as giving the federal government the power or authority to "take" even one square inch of an Indian nation's lands.

Therefore, at the present time, the Western Shoshone nations still has inherent rights to the lands within its Territory. Its territorial rights are full and absolute, and thus exclude any pretensions on the part of the United States. This also means that the Western Shoshone Nation's lands are as foreign to the jurisdiction of the federal government of the United States as the United States is foreign to, say, Canada or Mexico. At the time the U.S. Constitution was drafted, the respective States had no authority over the Western Shoshone Nation, and hence had no such authority to delegate to the federal government.

Significant Impacts to Water

The Twin Creeks Mine's destruction and contamination of water represents the most severe impact of this project. Destruction of this water constitutes an ecological and cultural genocide for the Western Shoshone. Water is the source of all life. All water is connected. Water is sacred as are the springs it flows from. The BLM, the State of Nevada and Santa Fe Pacific Gold are knowingly destroying water (drying up springs/creeks and leaving contaminated pit lakes) if this project is permitted. This is a crime against nature and a crime against humanity.

15-4 The impacts to springs will have a significant impact to the wildlife in the area, due to reduced water quantity and also to contaminated water sources. Unfortunately the BLM has failed to accurately assess the loss of these wetlands to wildlife. There is no documentation or evaluation of wildlife use of specific water sources, or any evaluation of the wildlife/plant life value of the springs, seeps and other wetlands in the project area. On page 3-131 it is admitted that wetland vegetative areas were not even quantitatively sampled during the baseline studies! How is it possible to know if reduced stream flows are having an effect on vegetation if you don't know how much of what you have to begin with? The extreme importance of springs and seeps to wildlife in this arid area would suggest that this should be a topic of extensive evaluation on a project which threatens to destroy these water sources.

Destruction of these water sources will prevent effective wildlife or grazing use of undisturbed areas around the mine. Many Western Shoshone consider hunting to be an integral form of cultural/spiritual expression thus such destruction of habitat represents not only an ecological loss but a cultural/spiritual loss as well. All land is not used equally and the loss of springs and wetland areas creates a disproportionate loss of habitat which is not accounted for in the DEIS.

15-5 Not only is the pit lake water a source of toxic metals and minerals, the waste rock dumps, heap leach pads and tailings facilities provide sources for the long term release of toxic substances. Post closure surface run off during periods of high moisture (rain and snow) would exceed State water quality standards. The period of time that this contaminated runoff can be expected to occur has not been predicted. Wildlife use of this surface runoff has not been evaluated. Plant and animal bioaccumulation of runoff constituents such as selenium has not been addressed. While it seems most of the mine facilities will produce contaminated runoff, no consideration has been given to the cumulative effects of this, especially when this will occur for decades, if not centuries after the closure of the mine.

15-6 The tailings impoundments will lead to water contamination and provide a long term source of contaminants. If liquid tailings need to be isolated in a pond lined with an impermeable layer, it seems common sense that the entire tailings facility should be lined with an impermeable layer as well. A proposed clay layer

Response to Letter 15

15-4 Please refer to Section 3.8.1.4 of the Final EIS wherein the BLM acknowledges that the dewatering violates Western Shoshone values. Mitigation measure TR-3 in Section 3.5.4.1 addresses the impacts to springs; however, the BLM acknowledges that the general impacts of dewatering on Western Shoshone values cannot be mitigated.

15-5 Please see the response to comment 1-17 regarding runoff from mine rock in the overburden and interburden storage facilities. The potential for surface water degradation from heap leach and tailings facilities was addressed in Section 3.2.2 of the Draft EIS. In summary, based on the design, construction, closure and reclamation activities, and site characteristics (low annual rainfall, high evaporation, lack of nearby perennial water sources, depth to ground water), the potential for water quality degradation from the tailings and heap leach facilities is considered minimal. Based on these project assumptions, the potential long-term effects to wildlife resources from surface water runoff and collection have not been identified for this EIS analysis.

15-6 Please see the response to comment 1-9 regarding liner design for tailings facilities and the response to comment 1-3 regarding remedial measures for failure of the fluid containment system. Regarding the effects of wind and water on the tailings facilities in the post closure period, all tailings facilities would be closed in accordance with

Letter 15 Continued

15-6 will "limit" migration of tailings fluid into groundwater, but we feel the linings of the tailings pond should completely stop any leakage of tailings fluid into the groundwater. In the event that a leak is detected in the tailings or heap leach facilities, how is this leak going to be stopped? The concentrated nature of metals in the leftover tailings creates an effective time bomb. Gradually wind and water will wear away any layer on the surface exposing the toxic innards. How is this going to be prevented?

15-7 The mine site is located in a geologically unstable area. The use of the MPE (Maximum Probable Earthquake) for design criteria on the waste dump and tailings facilities is inappropriate. Because of the permanent nature of these structures and the need to permanently isolate their contents, design should be based on the MCE (Maximum Credible Earthquake) Because Santa Fe Pacific Gold will probably not be in existence in several hundred years it seems prudent to design these facilities very conservatively to protect the future inhabitants of this area. Of particular concern is the lack of any detailed plan for the construction of these facilities. It is unacceptable that a DEIS be released without any information for evaluating the potential for the tailings facility to leak or breach during a storm or seismic event. Because of the huge amounts of potentially toxic substances contained in them, any such scenario would be a significant impact.

15-8 The creation of permanent pit lakes is unacceptable. These will create a permanent loss of groundwater through evaporation which would otherwise not occur. The water quality of these pit lakes would be very bad. Modeling in the DEIS indicates this as does the fact that this is a sulfide ore body. The exposure of wildlife to these contaminated waters is unavoidable. The mine site is located in the path of migratory waterfowl, and adjacent to the Humboldt River, a popular stop over point. Exposure of wildlife to toxic constituents of the pit water can lead to bioaccumulation. When the other pit lakes which are presently being created (Pipeline, Lone Tree, McCoy/Cove etc.) are taken into account, the potential to slowly poison wildlife especially waterfowl and birds of prey, is great. The cumulative impact of all these pit lakes must be evaluated. They do not exist in isolation of one another.

15-9 The DEIS states that Risk Assessments were completed to evaluate the potential impacts of pit lake water quality on wildlife. Risk Assessments are a relatively new art to the public and land management agencies. As such it is necessary to provide in the DEIS a detailed description of the process used to develop the risk analysis, including the parameters, assumptions, and models used. Many subjective decisions and assumptions are inherent in the risk assessment process and it is necessary that the public be aware of these assumption in order to make informed comments.

15-10 No credible mitigation is offered for the destruction or contamination of water. It is suggested that water supply developments such as guzzlers, catch basins, or wells would mitigate loss of or reduction in flow from springs and seeps. No further elaboration on the effectiveness of this mitigation, the cost, who would pay for it, and how it would be implemented are included. The public is left with the feeling that this possible mitigation is not being taken seriously by the BLM or Santa Fe Pacific Gold.

15-11 The drilling of wells, creation of water catchments and the installation of guzzlers, if it was to occur, does not mitigate the loss of natural water sources. Springs, creeks, and seeps flow naturally, without the intervention of man. Their water is free to all wildlife, and will flow as long as the Creator desires. The proposed mitigation requires the time, material and money of man to create and maintain them. They will last only as long as there is time, money, materials and man to maintain them. Often they are not as useful to plant and animal life as a natural spring or seep would be. These man made creations also do not possess the spiritual integrity that a natural spring or seep would. It is also unlikely that man made water sources would support the same plant diversity and distribution that current riparian areas exhibit.

15-12 It is our understanding that the creation of a pit lake which would degrade the waters of the State is illegal under NDEP regulations, yet this exactly what is going to happen. This presents long term impacts long

Response to Letter 15

Nevada Administration Code 445.446, 445A.429, 445A.430, and 445A.431. The proposed reclamation of the tailings facilities is addressed in Section 2.4.11.5 of the Final EIS. The proposed reclamation includes regrading and revegetation to effectively reduce the erosion potential by precipitation and wind. In addition, tailings areas C, D, and E and portions of large tailings area A and B would be covered by overburden and interburden material, which would further reduce the potential long-term wind and water erosion of the tailings material.

15-7 Please see the responses to comments 1-4, 1-5, and 1-6.

15-8 Evaporation losses from the pit lake were quantified and described in the Draft EIS. The comment regarding a permanent loss of ground water through evaporation from the lake surface is noted.

Regarding impacts to wildlife, as part of the EIS process, a detailed ecological risk assessment was performed to evaluate the potential risk to wildlife and waterfowl populations from both acute and chronic exposure to the future pit lake water. The risk assessment considered bioconcentration and bioaccumulation of chemicals by including uptake through the diet as part of the dose calculations. The results of the risk assessment are discussed in Section 3.5 and Appendix C of the Final EIS. In reference to the comment on cumulative impacts, three factors should be mentioned. First, for several of the receptor organisms evaluated for the Twin Creeks Mine and for other pit lakes, cumulative effects are essentially addressed in the risk assessment assumptions, since the analysis assumed that 100 percent of water and food would be obtained from the pit lake. This assumption is not likely, but it provided the most conservative evaluation. Therefore, even if organisms move from one pit lake to another to obtain water and food (e.g., migrating waterfowl), potential impacts to these animals are accounted for by assuming 100 percent ingestion at any of the individual pit lakes. Second, for certain receptor organisms (e.g., swallows, bats, sandpipers) chronic Toxicity Reference Values (e.g., based on reproduction) were used, which are considered more conservative than acute Toxicity Reference Values. Chronic exposure is one method of considering cumulative effects, since it assumes long-term occupation of a pit lake. Third, habitat limitations that would prevent or restrict waterfowl nesting, including the mallard at the future Twin Creeks pit lake, also would be applicable at other pit lakes, therefore preventing or limiting chronic exposure. For the same reason, no long-term, adverse impacts are anticipated for raptors

Response to Letter 15

(birds of prey), due to the limited presence of prey species at the pit lakes.

15-9 A detailed report entitled Ecological and Human Health Risk Assessments of the Future Pit Lakes: Twin Creeks Mine, Golconda, Nevada (Parametrix 1996) is available from the BLM Winnemucca District Office and the BLM Nevada State Office in Reno. This report describes the methodology for the risk assessment of the pit lake.

15-10 Additional mitigation for potential impacts to water resources has been included in the Final EIS. Please refer to Section 3.2.4.

15-11 Please see the response to comment 15-4.

Letter 15 Continued

15-12 after the closure of the mine. **We feel that Santa Fe Pacific Gold must retain full responsibility for any future impacts associated with this project.** Simply monitoring pit lake water quality for up to thirty years after closure (maximum allowed time under State law) is ludicrous, insulting and unacceptable! The BLM should be aware that under NEPA regulations "monitoring" does not constitute mitigation. Nowhere in the DEIS has there been any description of how degraded water quality in the pits would be remediated or cleaned up. There is a suggestion that material could be backfilled into the pits above the water level, but no real analysis has been done. Even if the backfilling to water level were possible that still wouldn't prevent the creation of contaminated water, it would simply make the surface inaccessible to wildlife.

15-13 The BLM and the State has used some very twisted logic to permit this project. At one point in the document (describing the baseline conditions) the groundwater around the proposed pit lake is described as being potential drinking water and thus the regulatory agencies would afford it the protection of drinking water. Yet after the pit is created the very same water (now filling the pit) has no applicable water quality standards. That defies logic and certainly makes the public question the sincerity and efficacy of those who are entrusted to protect and preserve the "public lands."

15-14 Monitoring of pit lake water quality and migration must occur for hundreds of years in the future. It also must be accompanied by a realistic and effective plan to deal with the water contamination. We do not see any commitment by the BLM, the State or Santa FE Pacific Gold to deal with these issues. It is also apparent that no plans for long term monitoring or cleanup exist. If mining is to occur on the so called "public lands" then the public is entitled to a firm commitment of accountability by the companies mining and the agencies overseeing this activity. As Western Shoshone people, we intend to remain on our lands for as long as the Creator wishes, far longer than Santa Fe Pacific Gold or the BLM will be around. Because of this we must look out for the long term effects of these projects. It is both our right and our responsibility to determine what activities take place on our ancestral homelands.

Consideration of Potential Future Access to Minerals in Deciding Whether or Not to backfill pits

15-15 In discussing the relevant factors in deciding whether or not the open pits will be backfilled, the DEIS includes the consideration of whether or not backfilling might be an obstacle to potential future access to gold. The Plan of Operations for which the Twin Creeks Mine DEIS was designed only deals with the exploitation of gold deposits which Santa Fe Pacific Gold Corporation considers economically recoverable under current market and technological conditions.

The DEIS, then, should also consider environmentally preferable alternatives with respect to the current project as outlined in the Twin Creeks Mine PO. An EIS should not be making determinations on environmental reclamation techniques based upon purely hypothetical, potential future scenarios which have no basis in currently available data.

In rejecting the alternative of total backfilling of all pits, it has been argued that partial or complete backfilling of mine pits would eliminate access to any remaining lower grade ore remaining in the pits and could preclude future recovery and utilization since the value of the remaining ore would have to be sufficiently high to support re-excavation of any backfilled materials.

This should not be a criteria for whether or not to backfill a pit. The EIS is for the project described in the Plan of Operations. If the PO is drawn up with certain parameters in mind, including designing the project around what is currently "economically feasible," then under NEPA, the decision of whether or not to backfill any of the pits should not rest on vague, unknown future scenarios of what "might be." What constitutes "reasonably. . . recoverable in the future?" The unknown future seems too arbitrary to be a viable consideration.

Response to Letter 15

15-12 As summarized in Section 3.2.2 in the Final EIS, the pit lake is not predicted to degrade the waters of the state. Also, please refer to the responses to comments 2-14 and 15-13.

15-13 Water quality standards are established to protect the potential beneficial uses of waters of the state. As explained in Section 3.2 of the Draft EIS, ground water is generally protected as a drinking water source; therefore, drinking water standards would apply. The pit lake would be fed by ground water inflow and precipitation that falls on the lake or runs off from the pit slopes. The lake is not predicted to have a surface or ground water outflow component. Water quality standards applicable to the lake water would depend on the potential beneficial uses of the lake designated by the state in the future. Since the pit lake is not intended to be a drinking water source for humans, a water supply for livestock, a recreational swimming area, or a fishery, standards to protect the lake for these uses would likely not apply.

15-14 Please see the response to comment 2-14.

15-15 The impact assessment and the BLM's selection of the agency preferred alternative are based on the Proposed Action (i.e., the proposed project). However, the Council on Environmental Quality regulations (40 Code of Federal Regulations 1508.8) require the assessment of indirect effects "which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." The burial of potential mineral resources would be an indirect effect of partial pit backfill. It should be noted, however, that additional environmental review would be necessary for a pit expansion to recover the additional mineralization.

Letter 15 Continued

15-15 When the project, as outlined in the PO and the DEIS, is completed, backfilling should be completed if it is environmentally preferable.

If the BLM wants to talk about the need for Santa Fe to exercise "cost efficiency," then why don't they use the definition provided in their Mule Canyon DEIS ? "Cost efficiency is usually measured using present net value. . ." Present value, i.e., not hypothetical possible future scenarios, like future gold extraction.

15-16 One alternative which we would like seriously considered is the possibility of mining the gold deposits above the water table. This would prevent any of the impacts from dewatering and pit lakes forming. While such an alternatives ma not allow for the complete extraction of the identified gold deposit, it could effectively prevent impacts associated with water quantity and quality.

15-17 An issue which concerns us is the discounting of certain options, alternatives, and measures because of the cost. If the BLM is going to permit this then the public is entitled to an accurate cost benefit analysis. It is not enough for Santa Fe Pacific Gold to claim that it will cost too much. If these are "public resources" we are dealing with then the "public" is entitled to know ho much is going to be spent on this project and how much Santa Fe Pacific Gold is going to make off of it. Only then can one make an informed decision on whether or not a certain option costs too much. It will always be in the interest for Santa Fe Pacific Gold or any other mining company to externalize as many costs as possible. They will only do that which makes them money, facilitates making money or which is required by law. What criteria does the BLM use in determining if a certain action would cost too much?

Short-term use versus Long-term productivity

15-18 The DEIS fails to discuss issues of short-term use versus long-term productivity. The 1/2 page mention does not constitute consideration of these issues. It is obvious that this mining project is a short term use of the area. It will produce a certain amount of monetary wealth which can be quantified. Much of this wealth will consumed in operating costs and the social expenses of employees and the surrounding communities. Little if any of this monetary wealth would go to the Western Shoshone people. The impacts of the project on other values, other wealth will be long lasting. The area proposed for development is currently rich in clean air, rich in water, rich in wildlife. The destruction and contamination of water sources (not a potential, but a definite impact even according to this inadequate document) is a long lasting effect, limiting the ability of the land to support animal and plant life. This life and this water would continue to produce indefinitely, if it were not destroyed by the mine. It is the Western Shoshone people, and perhaps those ranchers and other residents who choose to respect the land, that will be living with the consequences of this project. It is our opinion that we have far more to lose with the creation of this mine than we have to gain. Perhaps we would momentarily, monetarily gain, but our children, and our children's children would lose. The Western Shoshone Nation has a vested interest in the maintenance and future health of these lands.

Significant Impacts to Western Shoshone Cultural Sites

15-19 This project will have a significant impact on the historical remains of the Newe. The Shoshone Mike massacre site is an important and painful part of our history. We support the relatives of Shoshone Mike at Ft. Hall, and other Western Shoshone representatives who wish to see the site remain undisturbed. While we appreciate Santa Fe Pacific Gold's willingness to meet with Western Shoshone representatives, and especially their commitment to protect the Shoshone Mike massacre site by not covering it with a waste pile, it is unfortunate that they are unwilling to discuss other matters of importance to the Western Shoshone. Ideally we would like to see no waste dump or heap leach facility next to the marker, and the entire site and trail preserved in its natural condition in honor of our ancestors who died there. The mine will impact the plants, wildlife and

Response to Letter 15

15-16 The alternative to mine the gold deposit above the water table is not viable in the case of the Twin Creeks Mine. SFPG has the required permits and approvals in place and is currently mining the South Pit below the premining ground water elevation.

15-17 Please refer to the response to comment 11-2 regarding estimated pit backfill costs. Section 1502.23 of the Council on Environmental Quality regulations directs the consideration of costs in the decision, in addition to other important qualitative considerations.

15-18 The discussion of the short-term use of resources and the long-term productivity of the environment relative to the Twin Creeks Mine in Section 3.16 is qualitative in nature. The specific impacts are identified and quantified in the individual resource impact assessments in Sections 3.1 through 3.15 of the Draft and Final EIS.

15-19 Comment noted.

Letter 15 Continued

water who have given sustenance to the Newe since our beginnings, and by your definition these constitute "cultural resources."

15-19 We want you to know that we do not classify the things important to us like you do. All of Creation and our relationships within it have a cultural/spiritual context. Thus all the environmental impacts of this project have a cultural effect on us. The landscape, the shape of the land are cultural features. The destruction of these features which have been with the people since time immemorial causes psychological pain and suffering to those who still live with the memory of our ancestors and the hope for our descendants.

As we have said before water is source of all life, and undeniably sacred. Springs, therefore are very powerful places. By drying out these places you are participating in an attack on traditional Western Shoshone spirituality. Several anthropologists have commented on these issues and are relevant to your DEIS. This information is quoted from the Cortez Mine Expansion DEIS. Fowler writes:

> "Important from the perspective of religion is the concept of power (puha), an impersonal force which potentially can reside in any natural or living thing (water, geographic sites, plants, animals, person, etc.). This in turn translates into a view of the whole earth as sacred, and the duty of the Indian people to protect it. This affects attitudes toward land altering projects...as potentially harmful to the Earth and all who inhabit it."

R. Clemmer notes that:

> "Prayers are especially important in connection with places and spirits that live there. Prayers are made to spirits of plants and animals; to the 'Little Men'; and to the spirits of places that are regarded as power places...Power spots are always on mountains or on tops of prominent, isolated rock formations or in springs."

Why haven't Shoshone people been involved in the documentation and "mitigation" of archaeological sites?

290 archaeological sites have been identified in the Project area. So called mitigation involving excavation of some sites was conducted under "Programmatic Agreements" between the BLM, SHPO and the mining company. No Western Shoshone people were informed or involved in this process, despite the fact that an ethnographic study done in 1992 for the Mule Canyon Mine clearly indicated Western Shoshone concern about archaeological sites associated with their past. The report reads:

15-20

> Known archaeological sites in the study area, particularly residential bases, hunting blinds, rock shelters, caches and rock art sites, are regarded by Battle Mountain people as an important part of their cultural heritage. Tribal members are ambivalent about archaeological excavation, with some opposed to the removal of artifacts left on the site by their ancestors. Others favor excavation of important sites when destruction is inevitable, **but all agree that Western Shoshone people should be consulted on archaeological excavations and on the ultimate curation and/or display of artifacts.**

This involvement could have been easily accommodated within the "Programmatic Agreements" as described under the National Historic Preservation Act providing for the inclusion and consultation of "Indian tribes" and "interested persons." Despite these provisions the BLM has decided that Western Shoshone participation in decisions regarding the importance and fate of these "archaeological resources" was unnecessary.

Several questions need answering :

15-21 •What does "mitigation" mean, how was it decided what mitigation would take place, and why were no Western Shoshone invited to participate in this process after they had expressed their desire to be informed?

15-22 •Were any artifacts removed, where are they now?

Response to Letter 15

15-20 The cultural resources staff of the Shoshone-Bannock Tribes of Fort Hall and the Shoshone-Paiute Tribes of Duck Valley requested and received copies of all archaeological reports for review. There have been no mitigation activities at Twin Creeks, and no archaeological data recovery is planned. The mitigation measures described in Section 3.8.4 were developed with input from Native Americans at the tours and meetings described in Section 3.8.1.4 of the Final EIS.

15-21 Please see the response to comment 15-20.

15-22 Please see the response to comment 15-20.

Letter 15 Continued

15-23 Western Shoshone should also have access and input into the archaeological records and any further "mitigation" that is conducted at Twin Creeks.

Two articles in the U.N. Declaration on the Rights of Indigenous Peoples are of relevance to these particular comments.

Article 12

Indigenous peoples have the right to practice and revitalize their cultural traditions and customs. This includes the right to maintain, protect and develop the past, present and future manifestations of their cultures, such as archaeological and historical sites, artifacts, designs, ceremonies, technologies and visual and performing arts and literature, as well as the right to the restitution of cultural, intellectual, religious and spiritual property taken without their free and informed consent or in violation of their laws, traditions and customs.

Article 13

Indigenous peoples have the right to manifest, practice, develop and teach their spiritual and religious traditions, customs and ceremonies; the right to maintain, protect, and have access in privacy to their religious and cultural sites; the right to the use and control of ceremonial objects; and the right to the repatriation of human remains.

States shall take effective measures, in conjunction with the indigenous peoples concerned, to ensure that indigenous sacred places, including burial sites, be preserved, respected and protected.

15-24 The impacts of this project to the Western Shoshone were not adequately considered in the DEIS. The BLM's dismissal of legitimate Western Shoshone cultural concerns as not amounting to significant cultural resources to be considered is cultural bias of the first order. The BLM's action will have significant impacts on the Western Shoshone people and their religious beliefs. The review criteria used by the BLM are not culturally relevant and must be revised and revisited. The Project Area is within the confines of the traditional, and present, homelands of the Western Shoshone. The Western Shoshone have lived on this land for thousands of years, before any other people. Known to the Western Shoshone as "Newe Sogobia," this land was given to the Western Shoshone by the Creator for them to care for. The lands, the waters within, and the air above are directly connected with Western Shoshone religious life. Springs and seeps are of particular importance. As such, the lands themselves hold not only great traditional value for the Western Shoshone people, who have long lived on and used them, but also critical religious values. The DEIS follows a pattern of decisions by the BLM and other federal, state, and local agencies which effectively ignore the Western Shoshone people and contributes to the eventual extinction of their culture.

15-25 As an appendix to our comments we are including a copy of the comments prepared by Glenn Miller and Tom Meyers. They provide technical data to back up our concerns, and we would like these recorded as part of our comments.

Response to Letter 15

15-23 Comment noted.

15-24 Please see the response to comment 15-4.

15-25 Comment noted. The letter referenced and the associated responses are included in the Final EIS as Letter 13; it has not been reproduced here.

Letter 16

GETCHELL GOLD
CORPORATION

GETCHELL MINE · P.O. BOX 220
28 MILES N.E. · GOLCONDA, NV 89414
PHONE 702.635.5001
FAX 702.635.8015 OR 702.635.5262

August 15, 1996

CERTIFIED MAIL, RETURN RECEIPT REQUESTED

Mr. Gerald Moritz
EIS Project Manager
Bureau of Land Management("BLM")
Winnemucca District Office
5100 East Winnemucca Boulevard
Winnemucca, NV 89445

Re: Comments of Getchell Gold Corporation ("GGC") on Draft Environmental Impact Statement - Santa Fe Pacific Gold Corporation ("SFPG") Twin Creeks Mine

Dear Mr. Moritz:

This letter presents GGC's comments on the draft environmental impact statement ("draft EIS") for SFPG's Twin Creeks Mine. The deadline for the submittal of comments on the draft EIS is September 3, 1996. Thus, GGC's comments are being submitted in a timely fashion and should be incorporated into the formal administrative record of this proceeding.

This letter presents both general and specific comments regarding the adequacy and accuracy of the draft EIS. GGC's general comments challenge the adequacy under NEPA of the alternatives evaluation set forth in the Twin Creeks Mine draft EIS. GGC's specific comments identify those sections of the draft EIS that fail to adequately discuss current land ownership issues and their relation to the feasibility of the Preferred Alternative. As described in greater detail below, GGC believes that the draft EIS contains serious factual errors or omissions concerning the ownership of land upon which certain of the facilities identified in the BLM's Preferred Alternative are contemplated for construction. As GGC has previously communicated to BLM, the land in question is owned or controlled by GGC, not SFPG. A copy of GGC's May 16, 1996 letter to BLM concerning this issue is attached to this letter and GGC respectfully requests that it be placed in the Twin Creeks EIS administrative record and given due consideration in any BLM decision regarding the Twin Creeks Mine.

Letter 16 Continued

Mr. Gerald Moritz
August 15, 1996
Page 2

As of the date of this letter, SFPG has no legal right to utilize GGC's land for any purpose. Furthermore, SFPG is not currently engaged in any meaningful discussions with GGC that could potentially lead to the granting of such legal rights. As a result, GGC believes that the draft EIS is fundamentally flawed in that it fails to adequately describe SFPG's current land position, thereby exaggerating the feasibility of the Preferred Alternative and inappropriately skewing the analysis of alternatives in the document. GGC strongly believes that an adequate environmental impact statement for the Twin Creeks Mine must present an accurate assessment of the Preferred Alternative's questionable feasibility and must also evaluate in greater detail all other feasible alternatives not requiring the use of GGC land. **16-1**

In addition, GGC believes that a final EIS for the Twin Creeks Mine must indicate that the final EIS and the Record of Decision which supports it do not convey or grant any legal rights to the above referenced land to SFPG. GGC requests that the final environmental impact statement for the Twin Creeks Mine contain the following language so that SFPG, the BLM and the public fully understand that the final EIS, Record of Decision and any subsequent Plan of Operations do not grant any legal right to SFPG to utilize GGC's land and do not imply or suggest that GGC has consented to SFPG's use of GGC's land: **16-2**

> The final EIS and Record of Decision for the Twin Creeks Mine do not establish, convey or grant any legal rights or privileges to SFPG to undertake project activities on lands not owned or otherwise controlled by SFPG. SFPG's ability to undertake the selected alternative is expressly conditioned upon its acquisition of all necessary lands or the appropriate legal agreement to enter and use lands necessary to implement the selected alternative.

I. GENERAL COMMENTS ON THE ADEQUACY OF THE TWIN CREEKS MINE DRAFT EIS

Under NEPA, the evaluation of alternatives is "the heart of the environmental impact statement." 40 C.F.R. 1502.14. It is well established under the Council of Environmental Quality's regulations and relevant case law that an agency need only study "reasonable" alternatives. 40 C.F.R. 1502.14(a); see, e.g., Coalition for Canyon Preservation v. Bowers, 632 F.2nd 774,789 (9th Cir. 1980). What constitutes "reasonable alternatives" depends on the nature of the proposal for action and the facts in each case. See "Forty Most Asked Questions concerning CEQ's National Environmental Policy Act Regulations", 46 Fed. Reg.18026 (1981) ("Forty Questions"). Reasonable alternatives include those alternatives that "are practical or feasible from a technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant"(emphasis added). See Forty Questions, 46 Fed. Reg.18026, 18027 (Question 2A); see also NRDC, Inc. V. Morton, 458 F.2nd 827,834 (D.C. Cir. 1972). NEPA does not require that agencies evaluate unreasonable or infeasible alternatives. See Resources Limited v. Robertson, 35 F.3d 1300, (9th Cir., 1994).

Response to Letter 16

16-1 Section 2.3.15, Land Ownership (No Action alternative) and Section 2.4.12, Land Ownership (Proposed Action) have been added to the Final EIS to further discuss and explain the private land ownership question and to describe the possible consequences should SFPG and Getchell Gold Corporation (GGC) not reach a land agreement.

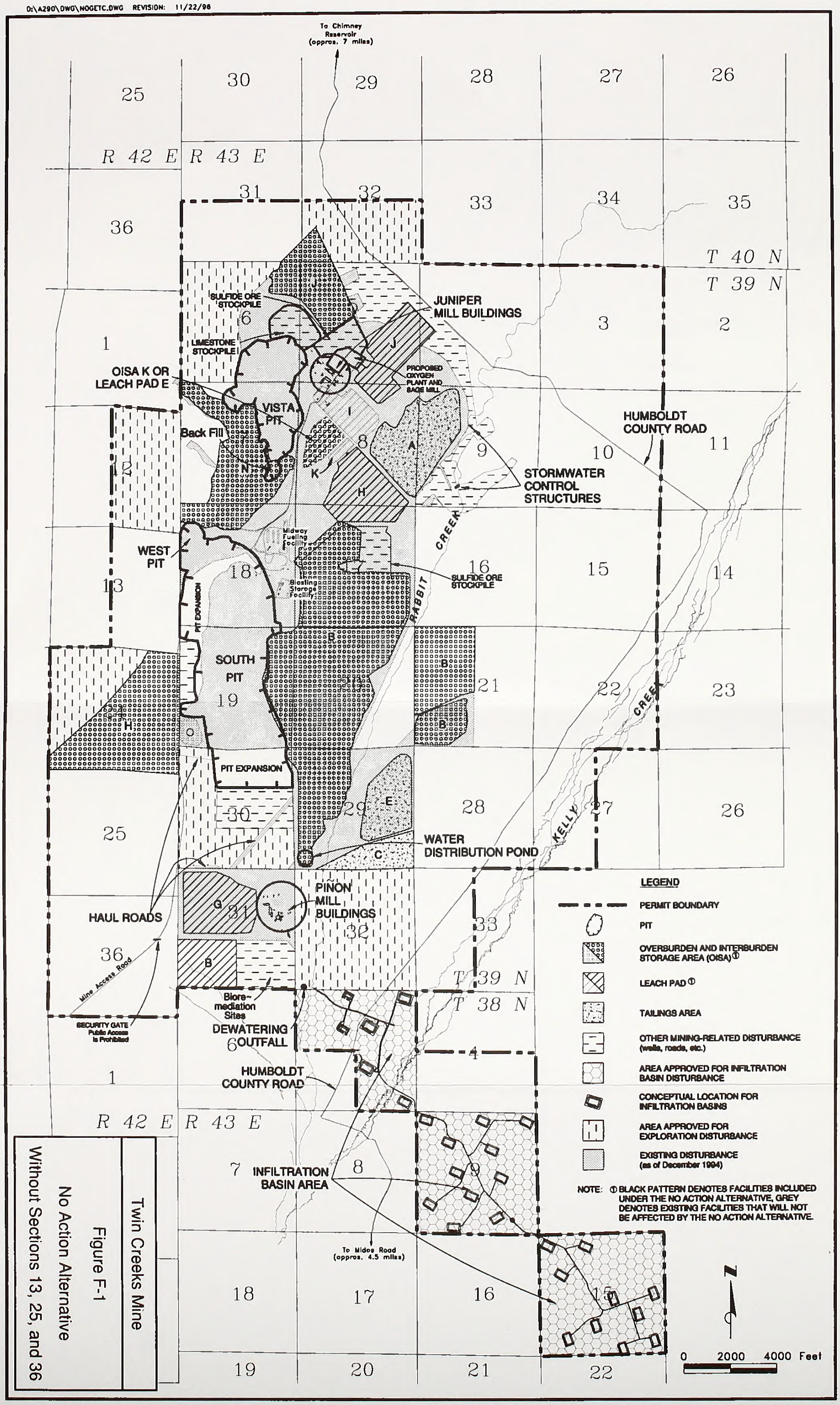
No Action Alternative. As indicated in the descriptions of the South Pit (Section 2.3.2) and overburden and interburden storage areas F and M Section 2.3.3), the facilities in Sections 13 and 25, Township 39 North, Range 43 East would require a land agreement with GGC prior to disturbing these lands. In the event that SFPG and GGC do not reach an agreement on SFPG's use of the private lands in question, SFPG could implement the No Action alternative without using Sections 13 and 25. Under this scenario, SFPG would not mine the ore in Section 13 of the South Pit; the total volume of material to be mined would be reduced by approximately 12.5 million tons. SFPG also would not use overburden and interburden storage areas F (Section 25) and M (Section 13), which have a total storage capacity of approximately 68.8 million tons. Storage areas H (Section 24) and B (Sections 17, 18, 20, 21, and 29) would accommodate the 56.3 million tons of overburden and interburden material (excluding the material from Section 13 of the South Pit) planned for storage areas F and M under the No Action alternative. Table F-3 and Figure F-1 illustrate the No Action alternative scenario without the use of the GGC-controlled lands.

Proposed Action. As indicated in the facility descriptions for the Proposed Action, the facilities in Sections 13 and 25, Township 39 North, Range 43 East, including a portion of the South Pit and overburden and interburden storage areas M and F, would require a land agreement between SFPG and GGC prior to disturbing these lands. Additionally, the construction of leach pad A in Section 36, Township 39 North, Range 43 East would require an agreement with

TABLE F-3
Changes in Material Balance if Sections 13, 25, and 36 are Not Available to SFPG
No Action Alternative

Project Component	Total Design Capacity (ktons)	Volume of Material (from DEIS) to be Placed (ktons)	Reduction in Volume of Material from Section 13 Pit (ktons)	Volume of Material to be Redistributed (ktons)	Excess Capacity (ktons)
Overburden and Interburden Storage Areas					
F (Section 25)	50,000	50,000	12,496	<37,504>	N/A
H (Section 24)	172,262	139,828	0	+32,434	0
M (Section 13)	18,750	18,750	0	<18,750>	N/A
B (Sections 17, 18, 20, 21, 29)	1,107,000	393,106	0	+23,820	713,894

D:\A290\DWG\NOGETC.DWG REVISION: 11/22/96



Twin Creeks Mine

Figure F-1

No Action Alternative

Without Sections 13, 25, and 36

the claimant of mining claims on that public land.

In the event that SFPG and GGC do not reach an agreement for SFPG's use of the lands in question, SFPG could implement the Proposed Action without using Sections 13, 25, and 36. The 270.5 million tons of material scheduled to be mined from the South Pit in Section 13 was proposed to be distributed as follows (in million tons):

- Mill ore - 25.9
- Leach ore - 14.9
- Overburden and Interburden - 229.7
- Total - 270.5

The reduction in the volume of mill ore under this scenario would not affect mill production or the capacity of the tailings impoundments.

The elimination of leach pad A in Section 36 would remove approximately 73 million tons of leach pad capacity. The remaining 58.2 million tons of leach ore (without the 14.9 million tons from Section 13 of the South Pit), originally scheduled for leach pad A in Section 36, would be added to leach pads B, E, and F, which have a proposed combined capacity of 55.7 million tons. Optional leach pad B in Section 31 would be expanded to accommodate an additional capacity of approximately 2.5 million tons of leach ore.

The elimination of overburden and interburden storage area F in Section 25 would eliminate a storage capacity of approximately 286.2 million tons. Storage are H, with an increased height to 450 feet (from 400 feet), would have an excess storage capacity of 82.4 million tons of material, which would accommodate the 75.3 million tons of overburden and interburden material originally proposed for storage areas F and M, excluding material from Section 13 of the South Pit. Table F-4 and Figure F-2 illustrate the Proposed Action scenario without the use of the GGC-controlled lands.

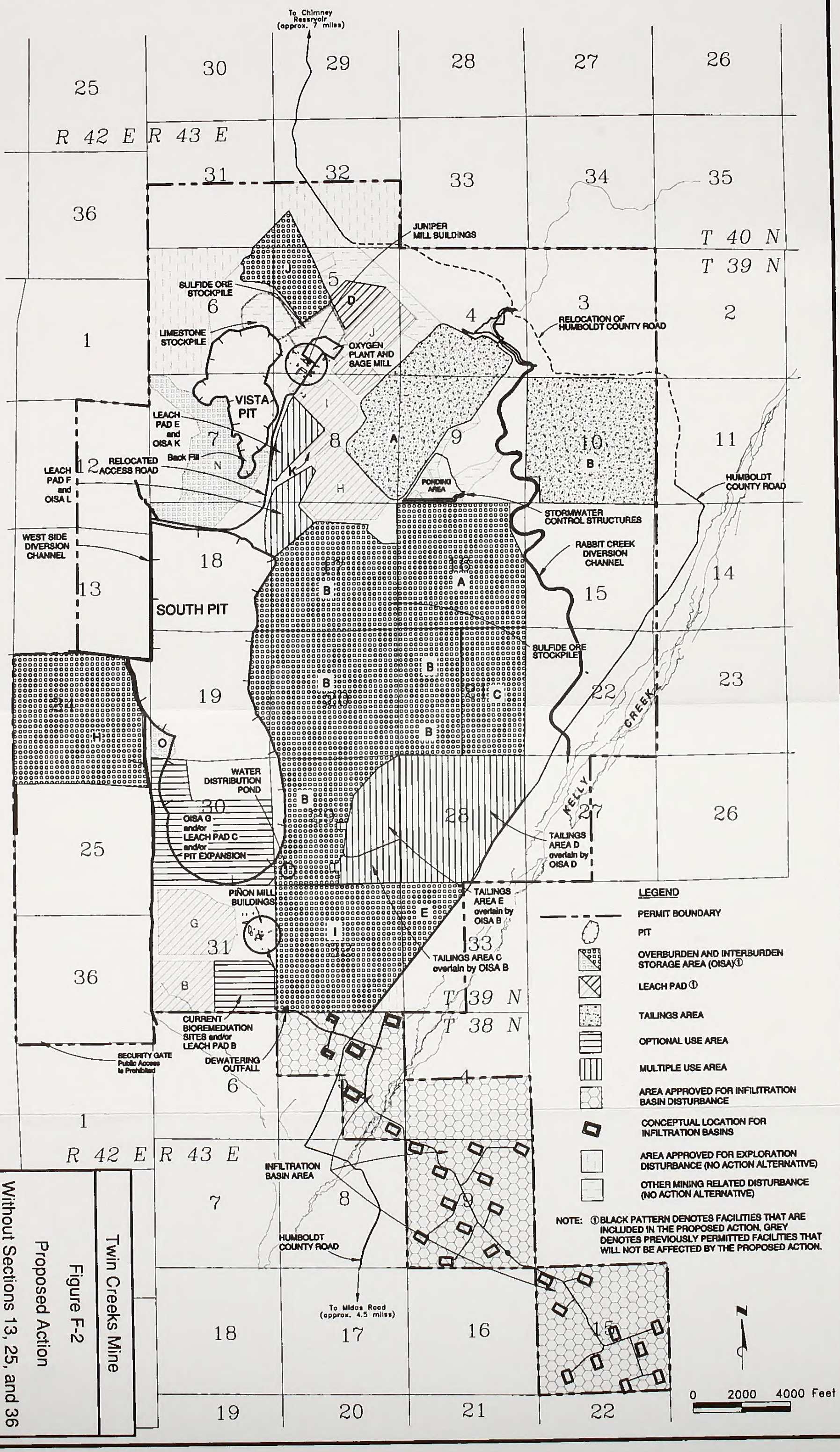
16-2 The EIS clearly states in Chapter 2 (project description) and in Section 3.10, Land Use and Access, that use of the private lands in question would require a land agreement between SFPG and GGC.

TABLE F-4
Changes in Material Balance if Sections 13, 25, and 36 are Not Available to SFPG
Proposed Action

Project Component	Total Design Capacity (ktons)	Volume of Material (from DEIS) Placed under the No Action Alternative (ktons)	Additional Volume of Material (from DEIS) to be Placed (ktons)	Reduction in Volume of Material fromSection 13 Pit (ktons)	Volume of Material to be Redistributed (ktons)	Excess Capacity (ktons)
Overburden and Interburden Storage Areas						
F (Section 25)		50,000	236,250	229,685	<56,565>	N/A
H (Section 24) (@450' height)	387,424	139,828	165,196	0	+75,315	7,085
M (Section 13)		18,750	0	0	<18,750>	N/A
Heap Leach Pads						
A (Section 36)		0	73,050	14,875	<58,175>	N/A
B (@ 200')	27,800	2,871	0	0	+27,375	<2,446>[1]
E (@ 200')	27,625	0	13,813	0	+13,812	0
F (@ 200')	33,977	0	16,989	0	+16,988	0

[1]Additional storage capacity would be created in Section 31 (heap leach pad B) to handle this material.

D:\A290\DWG\PRGETC.DWG REVISION: 11/22/96



Twin Creeks Mine

Figure F-2

Proposed Action

Without Sections 13, 25, and 36

Letter 16 Continued

Mr. Gerald Moritz
August 15, 1996
Page 3

The requirement that an agency examine reasonable alternatives is intended to "ensure that federal agencies have sufficiently detailed information to decide whether to proceed with an action in light of potential environmental consequences, and to provide the public with information on the environmental impact of a proposed action and encourage public participation in the development of that information." See Oregon Environmental Council v. Kunzsman, 817 F.2d 484,492. An agency must look at every reasonable alternative, with the range dictated by the nature and scope of the proposed action and sufficient to permit a reasoned choice. See Methow Valley Citizen's Council v. Regional Forester, 833 F.2d 810,815 (9th Cir. 1987), reversed on other grounds sub nom Robertson v. Methow Valley Citizen's Council, 490 U.S. 332, 109 S. Ct. 1835, 104 L. Ed. @d 351 (1989). Thus, the discussion of alternatives in an EIS must "foster informed decision making and informed public participation." See Idaho Conservation League v. Mumma, 956 F.2d 1058 (9th Cir. 1992). (Emphasis added.)

16-3 GGC believes that the draft EIS analysis of alternatives, and in particular, its discussion of the Preferred Alternative, fails to meet this standard. The analysis provides little information concerning ownership of the land necessary to implement the Preferred Alternative. For example, the draft EIS does not discuss lands in Section 13 and 25, T39N, R42E, owned by GGC that are included within the scope of the Preferred Alternative. The draft EIS fails to acknowledge that the Preferred Alternative cannot legally be implemented as described. Further, the draft EIS either ignores or provides little analysis of other alternatives that do not require the use of GGC's land. For example, GGC received a letter dated June 10, 1996 from SFPG to BLM (copy enclosed) indicating that SFPG had provided BLM with information concerning alternatives scenarios where no agreement with GGC was reached. However, the draft EIS does not present a detailed evaluation of these alternatives. Given that SFPG does not currently own or control all of the land necessary to implement the Preferred Alternative and has not entered into meaningful discussions with GGC concerning the acquisition of a legal right to make use of GGC's lands for such a purpose, it is GGC's position that the discussion in the draft EIS concerning the Preferred Alternative exaggerates its feasibility and provides BLM decision makers and the public with a skewed and inaccurate view of the alternatives under consideration. GGC believes that to rectify this inadequacy, the draft EIS must be rewritten to clearly and completely describe the current land ownership in and adjacent to the project area and provide a detailed evaluation of alternatives which do not require the construction of facilities on land owned or controlled by GGC. Specific instances in the draft EIS where these omissions occur are identified below in the Specific Comments section of this letter.

Response to Letter 16

16-3 Please see the response to comment 16-1.

Letter 16 Continued

Mr. Gerald Moritz
August 15, 1996
Page 4

II. SPECIFIC COMMENTS ON ERRORS OR OMISSIONS RELATED TO LAND OWNERSHIP IN THE TWIN CREEKS MINE DRAFT EIS

16-4 1. Draft EIS, p.2-12, 2-13. The draft EIS consistently asserts that Sections 13 and 25, T39N, R42E are or will be (it isn't clear) disturbed land even under the No Action Alternative (See Table 2-3, page 2-12; and Figure 2-3, page 2-13). These Sections of land are private land owned by GGC, are not disturbed by mining, and will be disturbed only with GGC's approval. As noted above, as of the date of this letter, GGC has not approved and is not engaged in negotiations concerning such approval with SFPG. The final EIS should not show this land as disturbed by mining under the No Action Alternative. GGC believes that the No Action Alternative should be corrected in the final EIS with Sections 13 and 25 shown as not disturbed.

16-5 2. Draft EIS p. 2-27. A review of the information shown on Table 2-5 (See page 2-27) of the draft EIS shows that 236,250 million tons out of 1,731,832 million tons (or ~14%) of the total overburden and interburden storage for the life of the mine is planned for Section 25, T39N, R42E, where SFPG has no agreement or right to operate. No alternative to using this private land is shown in the draft EIS. GGC believes that NEPA clearly requires BLM to develop and assess alternatives which do not use Section 25 and to demonstrate its impact on the mine plan.

16-6 3. Draft EIS, p.2-66. Section 2.7, entitled "*Agency Preferred Alternative,*" states that the land in Sections 22 and 27 of T39N, R43E are "private lands not owned by Santa Fe Pacific Gold Corporation." No mention is made in this section of the text of the similar private lands in Sections 13 and 25, T39N, R42E owned by GGC that are proposed to be included in the Preferred Alternative. The Getchell private lands impact critical areas of open pit and overburden storage. Sections 13, 25, and 36, T39N, R42E show gold mineralization, and GGC considers them to be prospective for further exploration and possible development. Given those and other factors, there certainly is no assurance that GGC will grant approval to SFPG to use this land for the Preferred Alternative. As a result, GGC believes that the draft EIS does not adequately or accurately assess the feasibility of the Preferred Alternative actions contemplated for this land or of other possible alternatives not requiring the use of GGC land.

16-7 4. Drat EIS, Figures 2-3, 2-5, 2-6, 2-11, 2-12. The north end of SFPG's South Pit is currently planned to infringe upon a portion of Section 13, T39N, R42E (See Figures 2-3, 2-5, 2-6, 2-11, and 2-12) where SFPG has no agreement and no right to mine. The exact impact of not being able to mine this Section of land is not assessed in the draft EIS. GGC believes that NEPA requires BLM to assess alternatives for not using Section 13 and its impact on the mine plan.

Response to Letter 16

16-4 Please see the response to comment 16-1. Additionally, the Draft EIS clearly states that use of the private lands in question would require a land agreement between SFPG and GGC.

16-5 Please see the response to comment 16-1.

16-6 Please see the response to comment 16-1.

16-7 Please see the response to comment 16-1.

Letter 16 Continued

Mr. Gerald Moritz
August 15, 1996
Page 5

16-8 5. Draft EIS, Table 2-5. The draft EIS shows Section 36, T39N, R42E as being used for a heap leach (See Figures 2-5, 2-6, 2-11, and 2-12; and Table 2-5). This Section is public land held by GGC through mining claims. GGC has not approved the use of this Section of land for a heap leach. No alternative to using this land is shown in the draft EIS. A review of the information shown on Table 2-5 of the draft EIS shows that 73.050 million tons out of 135,027 million tons(or ~54%) of the total heap leachable ore for the life of the project will be processed in Section 36, T39N, R42E. GGC believes that NEPA requires BLM to assess alternatives for not using Section 36 for a heap leach and its impact on the mine plan.

III. CONCLUSION

16-9 GGC believes that the draft EIS is fundamentally flawed in that it depicts a Preferred Alternative that cannot be implemented because the project proponent does not control the land necessary to accomplish the alternative and currently has no prospects to do so. Accordingly, the Preferred Alternative is not feasible and the balance of the alternatives analysis in the draft EIS is wholly inadequate. Neither the affected landowners, the public nor even the BLM have been adequately informed or provided with an accurate assessment of the feasibility of the available alternatives. Thus, under applicable regulations and pertinent case law, both the draft EIS and the NEPA process to date are defective and could not form the legal basis for BLM decisionmaking regarding the SFPG proposal. Given these serious flaws, GGC believes that the alternatives analysis must undergo a substantial revision and that the document should be republished as a revised draft EIS in order to obtain realistic and meaningful public participation prior to finalizing the document and moving forward with the decision. Finally, as required by applicable regulations, we would request that BLM provide specific written responses to the comments set forth above.

In closing, we appreciate the opportunity to participate in the public review process and would like to reiterate our request that GGC, as a potential affected landowner, be considered an interested party and provided with specific notice of all future meetings, draft documents or other developments. As always, we would be happy to meet with BLM to answer further questions or discuss the issues raised in these comments. Thank You.

Cordially,

John Barta

John Barta
Environmental Manager

Response to Letter 16

16-8 Please see the response to comment 16-1.

16-9 The comment regarding revisions to the alternatives analysis has been addressed (see the response to comment 16-1). In addition, the BLM has determined that the information provided in response 16-1 does not warrant the publication of a revised draft EIS. Finally, these written responses address your request for such.

Letter 16 Continued

FirstMiss Gold Inc.

Getchell Mine / (702) 635-5001
P.O. Box 220 / Golconda, Nevada 89414
Telecopier (702) 529-0447

May 16, 1996

Mr. Rob Ernst, Geologist
United States Bureau of Land Management
Winnemucca District Office
1500 E. Winnemucca Blvd.
Winnemucca, NV 89445

Re: Sections 13 & 25; T39N, R42E; Humboldt Co., NV
Getchell Mine

Dear Mr. Ernst:

This letter is written at the concern of the management of FirstMiss Gold and as a follow up to our conversation on Monday, May 6, 1996, regarding the referenced lands. Our discussion was triggered by FirstMiss Gold's recent discovery that these lands were included in a mine plan that Santa Fe Pacific Gold Corporation has filed with the BLM. It is my understanding, from our conversation, that the BLM's position on this issue is that the use of these two parcels of land is a private issue between two private land owners. I wish to document for you my company's understanding of the issues and the history of any mining plans.

The two referenced parcels of land were purchased by the original developers of the Getchell Mine from the railroad in 1937. They became part of Getchell Mines, Inc. in 1937 and were incorporated into the Goldfield Consolidated Mines Company in 1961. They were part of the land purchased by Conoco in 1972 and subsequently purchased by FRM Minerals, the predecessor company to FirstMiss Gold Inc., in 1983. They have remained in the possession of the company since then.

FirstMiss Gold and Santa Fe Pacific Gold have participated in data sharing at our common boundary for an extended period of time. This exchange has included drill hole and assay data, as well as projections of possible pit boundaries in Section 13 for use in economic evaluations of mining alternatives for the deposits there. We have a cooperative agreement to share groundwater information to support the monitoring requirements to which the Twin Creeks Mine has become committed. There are various other cooperative agreements as well.

I wish to inform you of a personal conversation with Pat Maley, of the Twin Creeks Mine, on Wednesday, May 8, 1996, stating that the potential use of our Section 25 as a waste rock dump is one option among several; that it has been included in mining plans only as an option; and that no slighting of FirstMiss Gold was intended in the manner that any mining plan may have been presented to anyone. We believe these statements, in fact, to be true.

Letter 16 Continued

Nevertheless, FirstMiss Gold employees cannot recollect, nor do our files contain, any formal written correspondence from any government regulatory agency or the project proponent with respect to the specific proposed plans by Santa Fe Pacific Gold Corporation for regulated mining activities on the two referenced parcels of our land at any time under any government regulatory program. The absence of any written correspondence to FirstMiss Gold specific to the proposed plans seems unusual to us given the inclusion of our private land in their longstanding applications with State and Federal regulatory agencies. FirstMiss Gold has been provided no information on the specific plans proposed for the referenced Section 25.

FirstMiss Gold has no agreement with Santa Fe Pacific Gold or any of its subsidiaries to purchase, lease or otherwise use either of these two sections of land for any purpose. There have been brief discussions, but the parties have not even reached the stage of exchanging preliminary drafts of letters of intent or agreements. Recently, discussions have intensified and it is our desire to have a mutually satisfactory agreement soon.

We request that the BLM include FirstMiss Gold in any future regulatory correspondence, reports or other documents that relate in any manner to these two parcels of land. We look forward to resolving any outstanding issues quickly and simply. Please call me with any questions or comments at 800/405-4946.

Cordially,
FIRSTMISS GOLD, INC.

John Barta
Environmental Manager

CC:
Bud Cribley, BLM/Winnemucca
Bill Thompson, FMG
R. David Russell, FMG
Pat James, SFPGCo
Steve Lang, SFPGCo
Pat Maley, SFPGCo

SANTA FE PACIFIC GOLD CORPORATION

TWIN CREEKS MINE
P.O. BOX 69
GOLCONDA, NEVADA 89414
TEL 702-623-9400 / 702-623-4300
FAX 702-635-9409

June 10, 1996

Mr. Bud Cribley, Assistant District Manager
United States Bureau of Land Management
Winnemucca District Office
1500 E. Winnemucca Blvd.
Winnemucca, NV 89445

Dear Mr. Cribley:

I am receipt of a letter dated May 16, 1996 from Mr. John Batra of FirstMiss Gold. In the letter, Mr. Barta notes that there is no agreement between Santa Fe Pacific Gold and FirstMiss on the use of either Section 13 or Section 25. Both sections are included in the Twin Creeks EIS.

Mr. Barta is correct in that there is no agreement currently in place regarding Santa Fe's use of these sections. This has been documented in the draft of the EIS with numerous references that any disturbances would first require prior approval from FirstMiss Gold. In addition, Santa Fe has provided maps to the BLM depicting disturbance that would result in both the no-action alternative and the proposed action, under both the scenario in which an agreement is reached with FirstMiss and the scenario in which no agreement is reach.

As a clarification, FirstMiss Gold was sent a written notice with respect to the proposed action in conjunction with the modification of Twin Creeks' County Special Use Permit in May 1995. That notice contained a description of the land affected. However, no one from FirstMiss chose to attend the public meeting.

It is Santa Fe's intention to continue discussions with FirstMiss regarding use of these sections, and I am hopeful that those discussions will be productive. Whether or not the discussions lead to an agreement on use of that area, I believe the impacts have been addressed in the information we have submitted.

Please let me know if you have any questions.

Sincerely,

Stephen A. Lang
General Manager, Twin Creeks Mine

cc:: John Barta/FMG
Pat Malcy/SFPG

Letter 17

AUG 15, 1996.

TWIN CREEK STATEMENT

AS A NATIVE I AM CONCERNED ABOUT PRESERVING THE MARKER OF WHERE SHOSHONE MIKE AND HIS FAMILY WERE SLAUGHTERED. HE WAS OUR LEADER AT ONE TIME SO IT IS IMPORTANT TO THE HISTORY OF OUR PEOPLE. SANTA FE GOLD SHOULD BE HAPPY TO PUT A MONUMENT UP WHERE THEIR LIVES ENDED, BECAUSE THEY HAVE MADE A LOT OF MONEY ON HIS LAND. UNDER THE TREATY OF PEACE AND FRIENDSHIP OF 1863 WITCH WAS AN AGREEMENT BETWEEN TWO NATIONS, THIS IS NEWE LAND. SHOSHONE MIKE WAS SUPPOSED TO BE FREE TO ROAM ON HIS LAND.

17-1 BECAUSE THE HISTORICAL VALUE OF THAT PLACE, I AM TOTALLY AGAINST THE LEACH PAD AND WASTE DUMP BEING PUT CLOSE TO IT. IT DOESN'T SEEM TO ME LIKE EUROPEAN AMERICANS WOULD DESECRATE THEIR OWN HISTORICAL PLACES IN THIS WAY. JUST THE IDEA THAT THE MINING OUTFIT SUGGESTED PUTTING THE WASTE DUMP AROUND IT SHOWS THEY WOULD RATHER COVER UP THE TRUTH ABOUT WHAT WAS DONE NOT TOO LONG AGO TO NATIVE PEOPLE. EIGHT PEOPLE LOST THEIR LIVES OVER A LIE.

THE AREA WHERE SHOSHONE MIKE AND HIS BAND WERE WIPED OUT SHOULD BE PROTECTED AND A MONUMENT PUT UP WITH THE TRUE HISTORY WRITTEN BY NEWE (SHOSHONE) PEOPLE SO OUR YOUNG PEOPLE CAN LEARN WHAT OUR PEOPLE WENT THROUGH.

Carlin Harney
Harvey Healey
Charlotte Healey
Delford Jim

Response to Letter 17

17-1 A new alternative (the West Side alternative) has been developed to protect the Shoshone Mike Massacre site; this alternative is described in Section 2.5.1.4 of the Final EIS. In addition, mitigation measures CR-1, CR-2, and CR-3 in Section 3.8.1.4 of the Final EIS would protect the site and information associated with this site.

Letter 18

645 Prebble
Winnemucca, NV 89445
September 2, 1996

Dear Mr. Moritz;

18-1

After reading the Environmental Impact Statement for Twin Creeks Mine, I am appalled that the BLM is going to grant the expansion on this mine. Not only will the expansion be granted but the mine has already been working on it for months. So much for putting a date on this case to decide it--they were PRE-APPROVED months ago.

The statement shows that the water quality and amount of water will suffer greatly; that Indian cultural sights will be destroyed and that wild-life and fish will suffer the consequences. I do not think that filling these gapping holes with water is "reclamation" I think it is the easiest way they can think of of getting out of really having to do something--like fill the holes back in and return them to their natural state.

For an example, the one pit will be greatly contaminated with arsenic and other dangerous chemicals but there will be a ditch dug around it. Do you realize that birds FLY? Do you realize that an animal (if thirsty enough) will do anything for a drink? Obviously not, as this pitiful excuse for a "reclamation" project has your whole-hearted approval.

I am sure that there was a lot of pressure on the BLM to approve this as the "Forces that Be" in Winnemucca would do anything to keep the mines going even though they have destroyed the land, raped the tax-payers of their GOLD and ruined this town and any others that are involved in this shameless business. However, at some point, the rights of the land and the protection of the same MUST come first. It can't be permanently put off as sooner or later it WILL be too late. I am amazed that this reason to destroy so much for MONEY will be approved.

I wonder who is going to protect this state and others if this kind of gross disregard for the environment and the land is allowed to continue. With this expansion in place, equilibrium will be reached in 230 YEARS. Do you people realize how many generations that is? Generations that will suffer with the mistakes that have been made and are being made today? I think that is an unthinkable legacy to leave a person's great-great-great-great-great grandchildren ANd especially, when all it means is a LOT OF MONEY for a few people.

This expansion is about THE WORST idea to ever be approved by you. I think that it should be stopped at once and no other mines be allowed to proceed with such inane, reprehensible ideas. This is a disgrace and should be allowed even if it does means spending money in the towns. It is a very bad idea.

Sincerely,

Sharon Harrer Sweeney

Response to Letter 18

18-1 Comments noted.

Public Meeting Comments
August 15, 1996

Comment	Response
Florine Maine- Western Shoshone Elder	
Overburden and interburden storage area F should be pulled farther back from the massacre site marker and more up on the ridge line; requested approximately 250 yards from the marker; concerned about potential stormwater runoff and drainage effects on the site.	Please see the response to comment 14-1.
Tom Myers - Great Basin Mine Watch	
Read letter at the public meeting - see Letter #12.	Please see the responses to comments 12-1 through 12-8.
Christopher Sewall- Western Shoshone Defense Project	
Concerned with streams and springs drying up.	Please see the responses to comments 1-37 and 1-38.
Ground water should be protected to drinking water standards; questioned why these standards do not apply to the pit lake water quality.	Please see the response to comment 15-13.
Cumulative water quality and dewatering impacts should be addressed with a basin-wide analysis.	Please see the response to comment 11-32.
Need long-term monitoring; State law only requires 30 years- what happens after that?	Please see the responses to comments 2-8 and 2-14.

Comment	Response
Carrie Dann- Western Shoshone Defense Project	
Water, earth, air, sun -- all are sacred and represent life. Taking one away takes life away. Dewatering is desecration of generations to come. Dewatering destroys our Indian religion and Indian ways, because water is sacred.	The Nevada State engineer, rather than the BLM, has authority over dewatering. The BLM acknowledges that dewatering may violate Western Shoshone religious values, and such violation cannot be mitigated. The BLM is requiring mitigation of dewatering effects in specific locations. Please refer to mitigation measure TW-3 in Section 3.5.4.1 of the Final EIS for a discussion of mitigation for potential habitat impacts associated with seeps, springs, and perennial drainages.
BLM and mines need to work together to preserve this site.	Please see the response to comment 14-1.
Read a letter at the public meeting-see Letter #17.	Please see the response to comment 14-1.

APPENDIX F ATTACHMENT

Water Quality: Advective and Diffusive Bedrock Oxidation Due to Ground Water Drawdown

Appendix F Attachment - F1 Water Quality: Advective and Diffusive Bedrock Oxidation Due to Ground Water Drawdown

As the regional water table is drawn down during mining operations, air (and associated oxygen) would be advectively transported into the regional bedrock, resulting in the oxidation of sulfide minerals. In addition, during the period over which the water table is below the sulfide bedrock surface, diffusion of atmospheric oxygen would result in additional oxidation of the exposed minerals. Oxidation products (i.e., acid and sulfate) would subsequently be flushed into ground water as the water table rebounds and the oxidized bedrock is rewetted (Figures 1 and 2). In addition, the portion of sulfide bedrock that would undergo dewatering but not rewetting would potentially be an additional source of oxidation products to the regional ground water as it is flushed by infiltrating rain water and snow melt.

Simple calculations were made to estimate the potential effect of sulfide bedrock oxidation on the pit lake water quality due to advective and diffusive oxygen loading. The results of these calculations demonstrated that:

- The rock contains enough buffering capacity to neutralize all acidity that could be produced by the advective and diffusive loading mechanisms, and consequently, metals associated with this acid release would mostly be attenuated (as demonstrated by the humidity cell test results).
- The total amount of sulfate produced by regional oxidation could potentially increase the total sulfate that could reach the lake by 12 percent over the amount calculated in the pit lake model.

ADVECTIVE TRANSPORT OF OXYGEN

The mass of oxygen introduced to the sulfide bedrock by advection would be proportional to the volume of water displaced by air due to dewatering of the regional bedrock. The total volume of dewatered sulfide bedrock was estimated to be 1.8×10^{9} cubic meters, corresponding to 1.34×10^{12} milligrams of oxygen. Of the dewatered bedrock, 7.11×10^{8} cubic meters (or 40 percent) would be rewetted, corresponding to 5.3×10^{11} milligrams of oxygen. These volumes were estimated based on the predicted drawdown cone at the end of mining and after 230 years of aquifer rebound, and on the elevation of the regional sulfide bedrock surface, assuming that the upper 150 feet of the bedrock are weathered (based on the average depth of oxide bedrock in the vicinity of the pit [Figure 3]). The calculation of the total volume of dewatered bedrock was verified independently by HCI, whose estimate was within 1 percent of the value presented above.

DIFFUSIVE TRANSPORT OF OXYGEN

The mass of oxygen introduced into the sulfide bedrock by diffusion is a function of the oxygen gradient, the diffusivity of the geologic units, the surface area of exposed sulfide bedrock, and the length of exposure. Diffusion of oxygen to the sulfide bedrock would be controlled by the diffusivity of the oxide bedrock which is estimated to have a specific yield of 0.0025. Using this value, the diffusion coefficient of oxygen into the pore space of the bedrock was calculated from the equation developed by Millington and Quirk (1964):

$$D = D_g^a \frac{(\phi - \theta)^{3.3}}{\phi^2}$$

where:

D_g^a = the diffusion coefficient of oxygen in air (square meters per second)

ϕ = the porosity of the bedrock (unitless)

θ = the moisture content of the bedrock (unitless)

At 25°C and 1 atmosphere, $D_g^a = 2.25 \times 10^{-5}$ square meters per second (Fuller et al. 1966). To be conservative, the specific yield and the porosity were assumed to be the same and the moisture content of the bedrock was assumed to be zero. The resulting oxygen diffusivity was calculated to be 9.3×10^{-9} square meters per second. The corresponding diffusive flux of oxygen across the oxidized bedrock was then calculated by Ficks law (Freeze and Cherry 1979):

$$J = D \frac{\Delta C}{\Delta X}$$

where:

J = diffusive flux of oxygen (grams per square meter per second)

ΔC = change in oxygen concentration across the oxide bedrock (grams per cubic meter) (assume (265-0) grams per cubic meter)

ΔX = the thickness of the oxide bedrock (meters) (assume 150 feet (45 meters); average depth of oxide bedrock in the vicinity of the pit).

The resulting diffusive flux of oxygen was calculated to be 5.4×10^{-8} grams per square meter per second.

The surface area of sulfide bedrock exposed would be a function of the changing water table elevations during mining and following rebound, as would be the duration of exposure to atmospheric oxygen before the sulfide rock is rewetted. To estimate the mass of oxygen loaded to sulfide bedrock via diffusion, the surface areas and exposure times of dewatered and subsequently rewetted sulfide bedrock were estimated based on the water table elevations before mining, at the end of mining, and after 10, 20, 30, 50, 80, 100, and 230 years of recovery (***Table F1-1***). These values were used to calculate a total of 7.43×10^{11} milligrams of oxygen introduced to the sulfide bedrock via diffusion from the start of mining until hydraulic steady state at 230 years after the end of mining.

In addition, 7.25×10^{6} square meters of sulfide bedrock is estimated to remain above the water table after the aquifer has reached hydraulic steady state, which could result in an additional 2.84×10^{12} milligrams of oxygen loading to the sulfide bedrock (***Table F1-1***). The oxidation products could be transported to ground water via infiltration of meteoric water. Although diffusive oxidation
over this area is included in the following calculations, the area represents only a 1.3 percent increase in the estimated surface area of sulfide bedrock above the water table before mining begins (5.67×10^{8} square meters), and contributions from this area are not expected to significantly affect the loading of oxidation products to ground water that is already taking place due to natural processes.

ACIDITY PRODUCED BY INTRODUCTION OF OXYGEN

The overall oxidation of pyrite and production of acidity is typically described by the following reaction (Stumm and Morgan 1981):

$$2FeS_2 + 15\frac{O_2}{2} + 7H_2O = 4SO_4^{2-} + 2Fe(OH)_3 + 8H^+$$

Pyrite oxidation stoichiometry indicates that every gram of oxygen produces 1.667 grams of $CaCO_3$-acidity. The total mass of oxygen introduced to the sulfide bedrock by advective and diffusive transport was calculated to be 4.92×10^{12} grams. Therefore, the total acidity produced by oxygen introduced to bedrock by advective and diffusive transport was calculated to be 2.12×10^{12} milligrams as $CaCO_3$.

The ability of the pore water to remain acidic would depend on the balance between acid produced and the neutralizing potential of the aquifer matrix. The neutralization potential of the bulk aquifer is:

$$NP(1-\theta)\rho$$

where NP is the neutralizing potential of the matrix (milligrams of $CaCO_3$/per gram), and ρ is the bulk density of the matrix (kilograms per cubic meter).

The neutralizing potential of the rocks chosen for the Twin Creeks humidity cells ranged from 0.08 to 582 milligrams of $CaCO_3$ per gram. The regional aquifer in the vicinity of the Twin Creeks Mine has a specific yield (i.e., drainable porosity available for air entry) of 0.0025 (HCI 1995) and a bulk density of approximately 2,650 kilograms per cubic meter. As a result, the net neutralizing potential of the dewatered sulfide bedrock was estimated to range from 3.8×10^{14} to 2.8×10^{18} milligrams of $CaCO_3$ assuming all of the neutralizing potential were available. However, the regional aquifer consists of fractured bedrock, and only a portion of the neutralizing potential would be available to neutralize acid produced. Even if the entire regional bedrock system is characterized by the lowest measured net neutralizing potential (resulting in a total of 3.8×10^{14} milligrams $CaCO_3$), only 2.2 percent of this neutralizing potential would

TABLE F1-1
Oxygen Loading to Dewatered and Rewetted Sulfide Bedrock Due to Diffusive Transport

Exposed Area of Sulfide Bedrock (m^2)	Oxygen Loading Rate (g/sec)	Period of Exposure (years)	Mass of Oxygen Loaded (mg)
2.97E+06	0.160	14	7.09×10^{10}
1.39E+06	0.040	24	5.69×10^{10}
7.43E+05	0.040	34	4.31×10^{10}
9.29E+04	0.005	35	5.54×10^{9}
1.86E+06	0.040	49	1.55×10^{11}
1.39E+06	0.040	74	1.75×10^{11}
7.43E+05	0.040	99	1.25×10^{11}
3.72E+05	0.020	174	1.10×10^{11}
TOTAL[a]			7.43×10^{11}

[a]Total oxygen loaded (mg) after 230 years of aquifer rebound.

be necessary to neutralize the acids produced by regional oxidation.

SULFATE PRODUCED BY INTRODUCTION OF OXYGEN

Pyrite oxidation stoichiometry indicates that sulfate is produced by oxygen at a mass ratio of 1 gram oxygen:1.6 grams sulfate (see equation on p. F1-1). Therefore, 7.88×10^{12} milligrams of sulfate were estimated to be produced and loaded to ground water due to advective and diffusive transport of oxygen to sulfide bedrock following drawdown. For comparison, the pit lake model indicates that the Twin Creeks Mine Proposed Action pit would contain 6.8×10^{13} milligrams of sulfate at 230 years after the end of mining. Consequently, the additional oxidation resulting from regional water table drawdown could potentially increase the sulfate concentration in the pit lake by as much as 12 percent, which is within the range of error for sulfate concentration estimated by the pit lake model.

In addition, oxidation within the portion of the sulfide rock that would undergo dewatering but not rewetting is potentially an additional source of sulfate to the pit lake by means of infiltrating rainfall and snowmelt. Over long time periods, infiltration through the unsaturated zone has the potential to flush oxidation products from this permanently dewatered zone. Considering the relative volumes of rewetted and permanently dewatered sulfide (for the advection analysis) and the surface area of the permanently dewatered zone, the flushing of oxidation products from the permanently dewatered zone has the potential to increase the concentration of sulfate in the pit lake by an as much as 12 percent.

REFERENCES

Freeze, R.A., and J.A. Cherry. (1979). *Groundwater*. Prentice-Hale, Inc. Englewood Cliffs, New Jersey.

Fuller, E.N., P.D. Schettler, and J.C. Giddings. (1966). A new method for prediction of binary gas diffusion coefficients. *Ind. Eng. Chem.* 58:19-27.

HCI. (1995). Hydrogeologic framework and numerical groundwater flow modeling of region surrounding Twin Creeks Mine, Humboldt County, Nevada. Prepared for Sante Fe Pacific Gold Corporation by Hydrologic Consultants, Inc., Lakewood, CO.

Millington, R.J., and J.P. Quirk. (1964). Formation factor and permeability equations. *Nature*. 202:143-145.

Stumm, W., and J.J. Morgan. (1981). *Aquatic Chemistry*. John Wiley and Sons. New York.

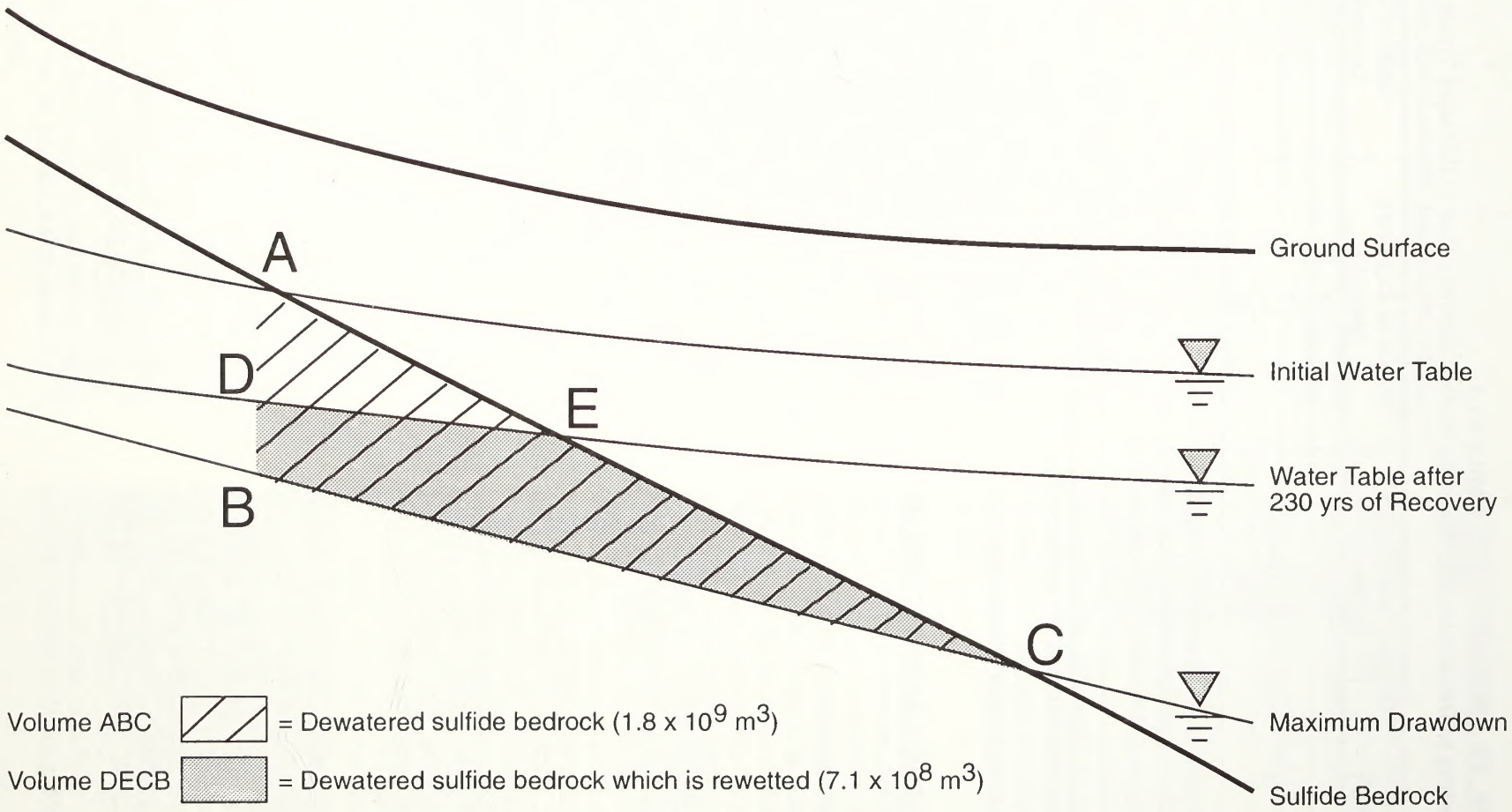
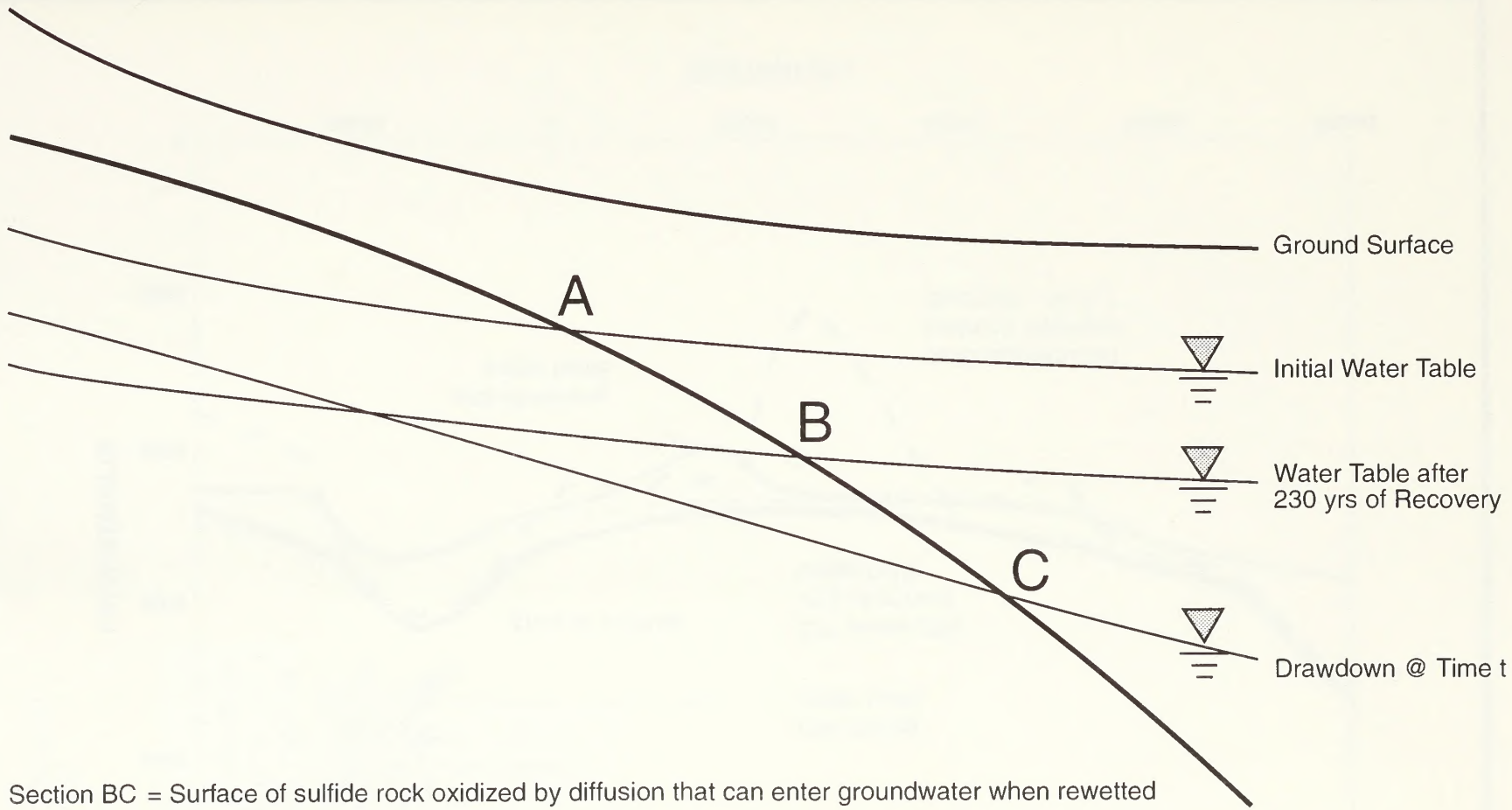


Figure F1-1. Conceptual schematic of sulfide bedrock oxidation due to advective oxidation.



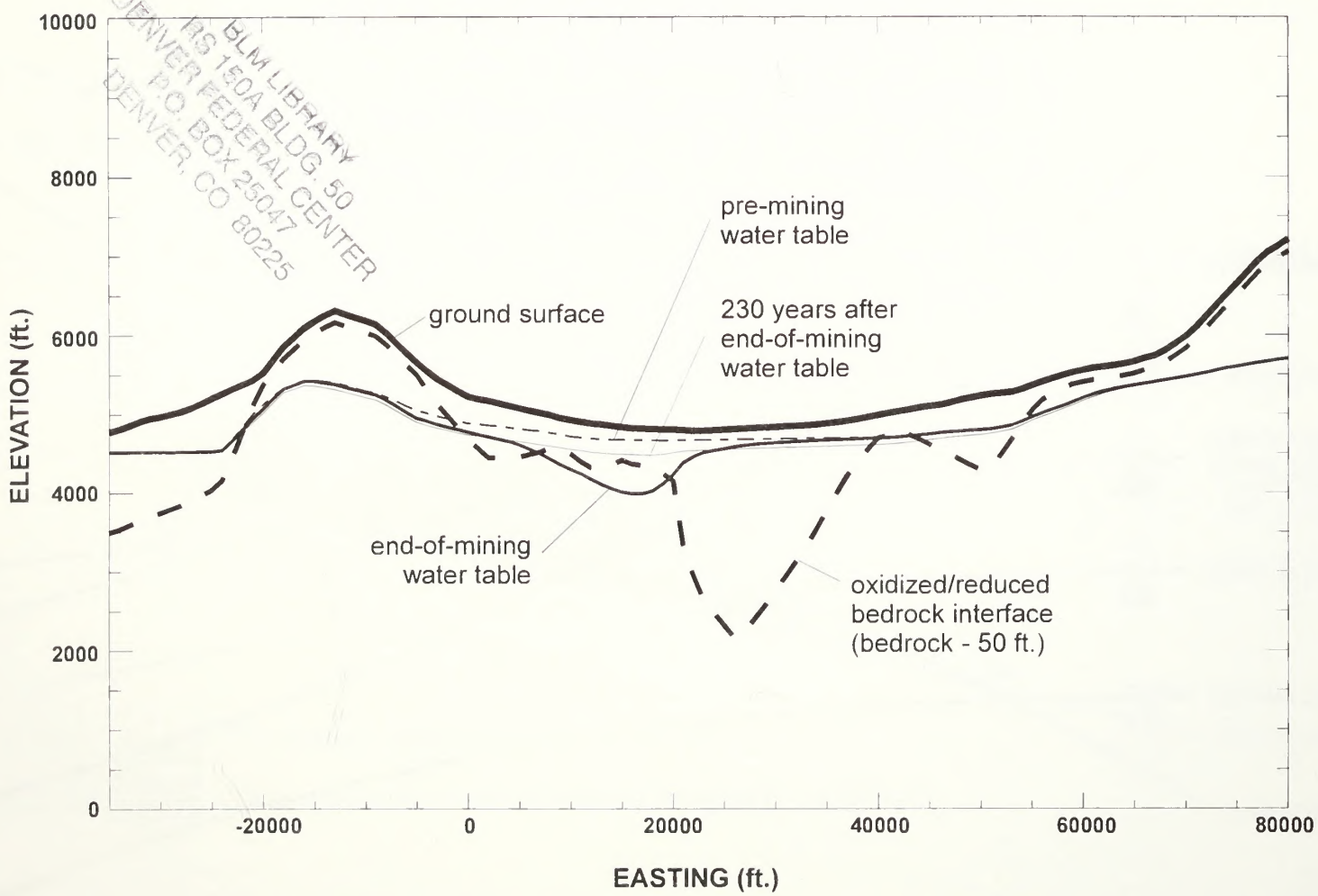
Section BC = Surface of sulfide rock oxidized by diffusion that can enter groundwater when rewetted

Section AC = Total surface of sulfide rock exposed to diffussive oxidation due to drawdown

Figure F1-2. Conceptual schematic of sulfide bedrock oxidation due to diffusive O_2 loading.

a290/feis/figures/sulfbed2.fh3 11/27/96

D:\A290\CDR\DDXSEC.CDR REVISION: 11/29/86



BLM LIBRARY
IRS 150A BLDG. 50
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, CO 80225

Figure F1-3. Geologic Section Along 40000 N

WER'S CARD

T956 1996b v.2c.2
of Land Management
win Creeks Mine

	OFFICE	DATE RETURNED

(Continued on reverse)

TD 195 .E37 T956 1996b v.2 c.2
U.S. Bureau of Land Management
Winnemucca Twin Creeks Mine

BLM LIBRARY
RS 150A BLDG. 50
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, CO 80225

Recycled Paper